Encyclopædia Britannica.

ASSOCIATION, the act of associating, or constituting a society, or partnership, in order to carry on some scheme or affair with more advantage.—The word is Latin, *associatio;* and compounded of *ad*, to, and *socio*, to join.

Association of Ideas, is where two or more ideas constantly and immediately follow or succeed one another in the mind, so that one shall almost infallibly produce the other, whether there be any natural relation between them or not. See Metaphysics.

Where there is a real affinity or connexion in ideas, it is the excellency of the mind, to be able to collect, compare, and range them in order, in its inquiries: but where there is none, nor any cause to be assigned for their accompanying each other, but what is owing to mere accident or habit: this unnatural association becomes a greater imperfection, and is, generally speaking, a main cause of error, or wrong deductions in reasoning, Thus the idea of goblins and sprights, it has been observed, has really no more affinity with darkness than with light; and yet let a foolish maid inculcate these ideas often on the mind of a child, and raise them there together, it is possible he shall never be able to separate them again so long as he lives, but darkness shall ever bring with it those frightful ideas. With regard to this instance, however, it must at the same time be observed, that the connection alluded to appears far from being either unnatural or absurd. See the article Apparition.

Such wrong combinations of ideas, Mr Locke shows, are a great cause of the irreconcileable opposition between the different sects of philosophy and religion: for we cannot imagine, that all who hold tenets different from, and sometimes even contradictory to, one another, should wilfully and knowingly impose upon themselves, and refuse truth offered by plain reason: but some loose and independent ideas are, by education, custom, and the constant din of their party, so coupled in their minds, that they always appear there together: these they can no more separate 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, consistency to nonsense, and is the foundation of the greatest, and almost of all the errors in the world.

Association forms a principal part of Dr Hartley's mechanical theory of the mind. He distinguishes it into synchronous and successive; and ascribes our simple and complex ideas to the influence of this principle or habit. Particular sensations result from previous vibrations conveyed through the nerves to the medullary substance of the brain; and these are so intimately associated together, that any one of them, when impressed alone, shall be able to excite in the mind the ideas of all the rest. Thus we derive the ideas of natural bodies from the association of the several sensible qualities with the names that express them, and with each other. The sight of part of a large building suggests the idea of the rest instantaneously, by a synchronous association of the parts; and the sound of the words, which begin a familiar sentence, brings to remembrance the remaining parts, in order, by successive association. Dr Hartley maintains, that simple ideas run into complex ones by association; and apprehends, that by pursuing and perfecting this doctrine, we may some time or other be enabled to analyze those complex ideas, that are commonly called the *ideas of reflection*, or *intellectual ideas*, into their several component parts, i. e. into the simple ideas of sensation of which they consist; and that this doctrine may be of considerable use in the art of logic, and in explaining the various phenomena of the human mind.

Association of Parliament. In the reign of King William III. the parliament entered into a solemn association to defend his Majesty's person and government against all plots and conspiracies; and all persons bearing offices civil or military, were enjoined to subscribe the association to stand by King William, on pain of forfeitures and penalties, &c. by stat. 7 and 8 W. III. c. 27.

Association, African. This is an institution which was formed in the year 1788, for the purpose of promoting discoveries in the interior parts of Africa. Out of the number of the members, of which this society consists, five are elected for the management of its funds and correspondence, and for the appointment of persons to whom the missions are assigned. Mr Ledyard was the first who was sent out, for accomplishing the object of the society. He undertook the adventurous task, of traversing from east to west, the widest part of the African continent, in the latitude which was ascribed to the Niger; and with this view he arrived at Cairo in August 1788. But before his projected journey commenced, he died, and the hopes that were entertained of this enterprising and persevering traveller were disappointed. Mr Lucas was next chosen by the committee.

committee. In October 1788, he embarked for Tripoli; and he was inftructed to proceed over the defert of Zaara to Fezzan, to collect all the information that could be obtained, refpecting the interior of the African continent, and to tranfmit it by way of Tripoli. He was then to return by way of Gambia, or the coaft of Guinea. But his peregrinations terminated at Mefurata. The difficulties and dangers which prefented themfelves deterred him from proceeding farther. He tranfmitted to the fociety only the refult of his conferences with the traders to Fezzan, with whom he was travelling; meafured back his road to Tripoli, and foon after returned to England.

The fociety ftill perfevered in its object, and in the year 1790, appointed Major Houghton, with inftructions to fail for the mouth of the Gambia, and to traverfe the country from weft to eaft. He arrived on the coaft in November the fame year, immediately commenced his journey, afcended the river Gambia to Medina, 900 miles diftant from its mouth, and thence proceeded to Bambouk, and to the adjoining kingdom of Kaffon, where, in September the year following, he unfortunately terminated his travels with his life, near to the town of Jarra.

Mr Park was engaged by the fociety in the fame fervice in 1795, and purfuing the route of Major Houghton, more fuccefsfully explored the banks of the Niger, to Sego and to Silla, the firft of that great line of populous cities which divide the fouthern from the northern deferts of Africa. The information which Mr Park collected, during his adventurous journey, was communicated to the fociety in 1798.

The laft of the labours of the fociety, was the appointment of Mr Horneman, who had offered himfelf to the committee in 1796. Having purfued for fome time the requifite ftudies to qualify himfelf for the undertaking, he departed from London in July 1797, and having remained fome time at Cairo, where he was received under the protection of Bonaparte, then commanding the French army in Egypt, he commenced his journey weftward with the caravan, in September 1798. In November following, he arrived at Mourzouk in Fezzan, from which his laft defpatches to the fociety were tranfmitted by way of Tripoli. And from the fuccefsful progrefs which he had made, he entertained great hopes of being able to penetrate farther to the fouthward and weftward, than any former traveller had been able to accomplifh. The difcoveries which have been communicated to the world, from the labours of thefe travellers, under the patronage of the fociety, are fully detailed in the account which we have given of Africa.

ASSOILZIE, in *Law*, to abfolve or free.

ASSONANCE, in *Rhetoric* and *Poetry*, a term ufed where the words of a phrafe or a verfe have the fame found or termination, and yet make no proper rhyme. Thefe are ufually accounted vicious in Englifh; though the Romans fometimes ufed them with elegancy; as, *Militem comparavit, exercitum ordinavit, aciem luftravit.*

ASSONANT RHYMES, is a term particularly applied to a kind of verfes common among the Spaniards, where a refemblance of found ferves inftead of a natural rhyme. Thus, *ligera, cubierta, tierra, mefa*, may anfwer each other in a kind of *affonant* rhyme, having each an *e* in the penult fyllable, and an *a* in the laft.

ASSUAN. See Syene.

ASSUMPSIT, in the *Law of England*, a voluntary or verbal promife, whereby a perfon affumes, or takes upon him to perform or pay any thing to another.

A promife is in the nature of a verbal convenant, and wants nothing but the folemnity of writing and fealing to make it abfolutely the fame. If therefore it be to do any explicit act, it is an exprefs contract, as much as any covenant; and the breach of it is an equal injury. The remedy indeed is not exactly the fame: fince, inftead of an action of covenant, there only lies an action upon the cafe, for what is called an *affumpfit* or undertaking of the defendant; the failure of performing which is the wrong or injury done to the plaintiff, the damages whereof a jury are to eftimate and fettle. As, if a builder promifes, undertakes, or affumes to Caius, that he will build and cover his houfe within a time limited, and fails to do it; Caius has an action on the cafe againft the builder for this breach of his exprefs promife, undertaking, or affumpfit; and fhall recover a pecuniary fatisfaction for the injury fuftained by fuch delay. So alfo in the cafe of a debt by fimple contract, if the debtor promifes to pay it and does not, this breach of promife entitles the creditor to his action on the cafe, inftead of being driven to an action of debt. Thus likewife a promiffory note, or note of hand not under feal, to pay money at a day certain, is an exprefs affumpfit; and the payee at common law, or by cuftom and act of parliament the indorfee, may recover the value of the note in damage, if it remains unpaid. Some agreements indeed, though never fo exprefsly made, are deemed of fo important a nature, that they ought not to reft in verbal promife only, which cannot be proved but by the memory (which fometimes will induce the perjury) of witneffes. To prevent which, the ftatute of frauds and perjuries, 29 Car. II. c. 3. enacts, that in the five following cafes no verbal promife fhall be fufficient to ground an action upon, but at the leaft fome note or memorandum of it fhall be made in writing, and figned by the party to be charged therewith: 1. Where an executor or adminiftrator promifes to anfwer damages out of his own eftate. 2. Where a man undertakes to anfwer for the debt, default, or mifcarriage, of another. 3. Where any agreement is made upon confideration of marriage. 4. Where any contract or fale is made of lands, tenements, or hereditaments, or any intereft therein. 5. And laftly, where there is any agreement that is not to be performed within a year from the making hereof. In all thefe cafes a mere verbal affumpfit is void.

From thefe exprefs contracts the tranfition is eafy to thofe that are only implied by law. Which are fuch as reafon and juftice dictate, and which therefore the law prefumes that every man has contracted to perform; and, upon this prefumption, makes him anfwerable to fuch perfons as fuffer by his non-performance.

Thus, 1. If I employ a perfon to tranfact any bufinefs for me, or perform any work, the law implies that I undertook, or affumed, to pay him fo much as his labour deferved; and if I neglect to make him amends, he has a remedy for his injury by bringing his action on the cafe upon this implied affumpfit; wherein he is much

Aſſumpſit.

at liberty to ſuggeſt that I promiſed to pay him ſo much as he reaſonably deſerved, and then to aver that his trouble was really worth ſuch a particular ſum, which the defendant has omitted to pay. But this valuation of his trouble is ſubmitted to the determination of a jury; who will aſſeſs ſuch a ſum in damages as they think he really merited. This is called an *aſſumpſit* on a *quantum meruit*.

2. There is alſo an implied aſſumpſit on a *quantum valebat*, which is very ſimilar to the former; being only where one takes up goods or wares of a tradeſman, without expreſsly agreeing for the price. There the law concludes, that both parties did intentionally agree that the real value of the goods ſhould be paid; and an action on the caſe may be brought accordingly, if the vendee refuſes to pay that value.

3. A third ſpecies of implied aſſumpſit is when one has had and received money belonging to another without any valuable conſideration given on the receiver's part; for the law conſtrues this to be money had and received for the uſe of the owner only; and implies that the perſon ſo receiving, promiſed and undertook to account for it to the true proprietor. And, if he unjuſtly detains it, an action on the caſe lies againſt him for the breach of ſuch implied promiſe and undertaking; and he will be made to repair the owner in damages, equivalent to what he has detained in ſuch violation of his promiſe. This is a very extenſive and beneficial remedy, applicable to almoſt every caſe where the defendant has received money which *ex æquo et bono* he ought to refund. It lies for money paid by miſtake, or on a conſideration which happens to fail, or through impoſition, extortion, or oppreſſion, or where undue advantage is taken of the plaintiff's ſituation.

4. Where a perſon has laid out and expended his own money for the uſe of another at his requeſt, the law implies a promiſe of repayment, and an action will lie on this aſſumpſit.

5. Likewiſe, fifthly, upon a ſtated account between two merchants, or other perſons, the law implies that he againſt whom the balance appears has engaged to pay to the other; though there be not any actual promiſe. And from this implication it is frequent for actions on the caſe to be brought, declaring that the plaintiff and defendant had ſettled their accounts together, *inſimul computaſſent* (which gives name to this ſpecies of aſſumpſit); and that the defendant engaged to pay the plaintiff the balance, but has ſince neglected to do it. But if no account has been made up, then the legal remedy is by bringing a writ of *account de computo;* commanding the defendant to render a juſt account to the plaintiff, or ſhow the court good cauſe to the contrary. In this action, if the plaintiff ſucceeds, there are two judgments; the firſt is, that the defendant do account (*quod computet*) before auditors appointed by the court; and when ſuch account is finiſhed, then the ſecond judgment is, that he do pay the plaintiff ſo much as he is found in arrear.

6. The laſt claſs of contracts, implied by reaſon and conſtruction of law, ariſes upon this ſuppoſition, that every one who undertakes any office, employment, truſt, or duty, contracts with thoſe who employ or intruſt him, to perform it with integrity, diligence, and ſkill: and if by his want of either of thoſe qualities any injury accrues to individuals, they have therefore their remedy in damages by a ſpecial action on the caſe. A few inſtances will fully illuſtrate this matter. If an officer of the public is guilty of neglect of duty, or a palpable breach of it, of non-feaſance, or of mis-feaſance; as, if the ſheriff does not execute a writ ſent to him, or if he wilfully makes a falſe return thereof; in both theſe caſes the party aggrieved ſhall have an action *on the caſe* for damages to be aſſeſſed by a jury. If a ſheriff or gaoler ſuffers a priſoner who is taken upon meſne proceſs (that is, during the pendency of a ſuit) to eſcape, he is liable to an action *on the caſe*. But if, after judgment, a gaoler or a ſheriff permits a debtor to eſcape, who is charged in execution for a certain ſum; the debt immediately becomes his own, and he is compellable by action of *debt*, being for a ſum liquidated and aſcertained, to ſatisfy the creditor in his whole demand. An advocate or attorney that betray the cauſe of their client, or, being retained, neglect to appear at the trial, by which the cauſe miſcarries, are liable to an action on the caſe, for a reparation to their injured client. There is alſo in law always an implied contract with a common innkeeper, to ſecure his gueſt's goods in his inn; with a common carrier or barge-maſter, to be anſwerable for the goods he carries; with a common farrier, that he ſhoes a horſe well, without laming him; with a common taylor, or other workman, that he performs his buſineſs in a workmanlike manner: in which if they fail, an action on the caſe lies to recover damages for ſuch breach of their general undertaking. Alſo, if an innkeeper, or other victualler, hangs out a ſign and opens his houſe for travellers, it is an implied engagement to entertain all perſons who travel that way; and upon this univerſal aſſumpſit an action on the caſe will lie againſt him for damages, if he without good reaſon refuſes to admit a traveller. In contracts likewiſe for ſales, if the ſeller doth upon the ſale warrant it to be good, the law annexes a tacit contract to this warranty, that if it be not ſo, he ſhall make compenſation to the buyer: elſe it is an injury to good faith, for which an action on the caſe will lie to recover damages.

Aſſumpſit || Aſſumptive.

ASSUMPTION, a feſtival in the Romiſh church, in honour of the miraculous aſcent of the Virgin Mary into heaven: the Greek church, who alſo obſerve this feſtival, celebrate it on the 15th of Auguſt with great ceremony.

Assumption, in *Logic*, is the minor or ſecond propoſition in a categorical ſyllogiſm.

Assumption is alſo uſed for a conſequence drawn from the propoſition whereof an argument is compoſed.

Assumption, an iſland in North America, in the gulf of St Lawrence, at the mouth of the great river of the ſame name. It is covered with trees. W. Long. 60. 40. N. Lat. 49. 30.

Assumption, a large and handſome town of Proper Paraguay, on the river of the ſame name in South America. It is a biſhop's ſee, is well peopled, and ſeated in a country fruitful in corn and fruits, whoſe trees are always green. There is likewiſe a quantity of paſture, and the air is temperate and ſalutary. W. Long. 60. 40. S. Lat. 34. 10.

ASSUMPTIVE arms, in *Heraldry*, are ſuch as a perſon has a right to aſſume, with the approbation of his ſovereign, and of the heralds: thus, if a perſon who has no right by blood, and has no coat of arms,

ſhall

shall captivate in any lawful war any gentleman, nobleman, or prince, he is, in that case, entitled to bear the shield of that prisoner, and enjoy it to him and his heirs for ever.

ASSURANCE, or INSURANCE, in *Commerce*. See INSURANCE.

ASSUROR, a merchant, or other person, who makes out a policy of assurance, and thereby insures a ship, house, or the like.

ASSUS, or ASSOS, in *Ancient Geography*, a town of Troas (though by others supposed to be of Mysia), and the same with Apollonia (Pliny); but different from the Apollonia on the river Rhyndacus. Ptolemy places it on the sea-coast, but Strabo more inland; if he does not mean the head of an inland bay, as appears from Diodorus Siculus. It was the country of Cleanthes the stoic philosopher, who succeeded Zeno. St Luke and others of St Paul's companions, in his voyage (Acts xx. 13. 14.), went by sea from Troas to Assos: but St Paul went by land thither, and meeting them at Assos, they all went together to Mytelene. It is still called *Asso*. E. Long. 27. 30. N. 38. 30.

ASSYRIA, an ancient kingdom of Asia, concerning the extent, commencement, and duration of which, historians differ greatly in their accounts. Several ancient writers, in particular Ctesias and Diodorus Siculus, have affirmed, that the Assyrian monarchy, under Ninus and Semiramis, comprehended the greater part of the known world. Had this been the case, it is not likely that Homer and Herodotus would have omitted a fact so remarkable. The sacred records intimate, that none of the ancient states or kingdoms were of considerable extent; for neither Chederlaomer, nor any of the neighbouring princes, were tributary or subject to Assyria; and we find nothing of the greatness or power of this kingdom in the history of the judges and succeeding kings of Israel, though the latter kingdom was oppressed and enslaved by many different powers in that period. It is highly probable, therefore, that Assyria was originally of small extent. According to Ptolemy, it was bounded on the north by Armenia Major; on the west by the Tigris; on the south by Susiana; and on the east by Media.

Playfair's Chronology.

It is probable, that the origin and revolutions of the Assyrian monarchy were as follows.—The founder of it was Ashur, the second son of Shem, who went out of Shinar, either by the appointment of Nimrod, or to elude the fury of a tyrant; conducted a large body of adventurers into Assyria, and laid the foundation of Nineveh (Gen. x. 11.) These events happened not long after Nimrod had established the Chaldæan monarchy, and fixed his residence at Babylon. The Persian historians suppose that the kings of Persia of the first dynasty were the same with the kings of Assyria, of whom Zohah, or Nimrod, was the founder of Babel. (Herbelot Orient. Bibl. v. *Bagdad*). It does not, however, appear that Nimrod reigned in Assyria. The kingdoms of Babylon and Assyria were originally distinct and separate (Micah, v. 6.); and in this state they remained until Ninus conquered Babylon and made it tributary to the Assyrian empire. Ninus the successor of Asher (Gen. x. 11. Diod. Sic. lib. 1.), seized on Chaldæa, after the death of Nimrod, and united the kingdoms of Assyria and Babylon. This great prince is said to have subdued Asia, Persia, Media, Egypt, &c. If he did so, the effects of his conquests were of no duration; for in the days of Abraham, we do not find that any of the neighbouring kingdoms were subject to Assyria. He was succeeded by Semiramis; a princess of an heroic mind; bold, enterprising, fortunate; but of whom many fabulous things have been recorded. It appears, however, that there were two princesses of the same name, who flourished at very different periods. One of them was the consort of Ninus; and the other lived five generations before Nitocris queen of Nebuchadnezzar (Euseb. Chron. p. 58. Herod. lib. i. c. 184). This fact has not been attended to by many writers.

Whether there was an uninterrupted series of kings from Ninus to Sardanapalus, or not, is still a question. Some suspicion has arisen, that the list which Ctesias has given of the Assyrian kings is not genuine; for many names in it are of Persian, Egyptian, and Grecian extraction.

Nothing memorable has been recorded concerning the successors of Ninus and Semiramis. Of that effeminate race of princes it is barely said, that they ascended the throne, lived in indolence, and died in their palace at Nineveh. Diodorus (lib. ii.) relates, that, in the reign of Teutames, the Assyrians, solicited by Priam their vassal, sent to the Trojans a supply of 20,000 foot and 200 chariots, under the command of Memnon, son of Tithonus president of Persia: But the truth of his relation is rendered doubtful by the accounts of other writers.

Sardanapalus was the last of the ancient Assyrian kings. Contemning his indolent and voluptuous course of life, Arbaces, governor of Media, withdrew his allegiance, and rose up in rebellion against him. He was encouraged in this revolt by the advice and assistance of Belesis, a Chaldean priest, who engaged the Babylonians to follow the example of the Medes. These powerful provinces, aided by the Persians and other allies, who despised the effeminacy, or dreaded the tyranny of their Assyrian lords, attacked the empire on all sides. Their most vigorous efforts were, in the beginning, unsuccessful. Firm and determined, however, in their opposition, they at length prevailed, defeated the Assyrian army, besieged Sardanapalus in his capital, which they demolished, and became masters of the empire, B. C. 821.

After the death of Sardanapalus, the Assyrian empire was divided into three kingdoms, viz. the Median, Assyrian, and Babylonian. Arbaces retained the supreme power and authority, and fixed his residence at Ecbatana in Media. He nominated governors in Assyria and Babylon, who were honoured with the title of *kings*, while they remained subject and tributary to the Median monarchs. Belesis received the government of Babylon as the reward of his services; and Phul was intrusted with that of Assyria. The Assyrian governor gradually enlarged the boundaries of his kingdom, and was succeeded by Tiglath-pileser, Salmanasar, and Sennacherib, who asserted and maintained their independency. After the death of Assar-haddon, the brother and successor of Sennacherib, the kingdom of Assyria was split, and annexed to the kingdoms of Media and Babylon. Several tributary princes afterwards reigned in Nineveh; but no particular account of them is found in the annals of ancient nations. We hear

Assythment ‖ Asteism.

hear no more of the kings of Assyria, but of those of Babylon. Cyaxares king of Media assisted Nebuchadnezzar king of Babylon, in the siege of Nineveh, which they took and destroyed, B. C. 606. The Chaldean or Babylonish kingdom was transferred to the Medes, after the reign of Nabonadius, son of Evilmerodach, and grandson of Nebuchadnezzar. He is styled Belshazzar in the sacred records, and was conquered by Cyrus, B. C. 538.

ASSYTHMENT. See ASSITHMENT.

ASTA, an inland town of Liguria, a colony (Ptolemy) on the river Tanarus: Now *Asti*. E. Long. 8. 15. N. Lat. 44. 40.

ASTA Regia, a town of Bætica, (Pliny); situated at the mouth of the Bætis which was choaked up with mud, to the north of Cadiz: 16 miles distant from the port of Cadiz, (Antonine). Its ruins show its former greatness. Its name is Phœnician, denoting a *frith* or arm of the sea, on which it stood. It is said to be the same with XERA; which see.

ASTABAT, a town of Armenia, in Asia, situated near the river Aras, 12 miles south of Nakshivan. The land about it is excellent, and produces very good wine. There is a root peculiar to this country, called *ronas;* which runs in the ground like liquorice, and serves for dyeing red. It is very much used all over the Indies, and in it they have a great trade. E. Long. 46. 30. N. Lat. 39. 0.

ASTANDA, in *Antiquity*, a royal courier or messenger, the same with ANGARUS.—King Darius of Persia is said by Plutarch, in his book on the fortune of Alexander, to have formerly been an *astanda*.

ASTAROTH, or ASHTAROTH, in *Antiquity*, a goddess of the Sidonians.—The word is Syriac, and signifies *sheep*, especially when their udders are turgid with milk. From the fecundity of these animals, which in Syria continue to breed a long time, they formed the notion of a deity, whom they called *Astaroth*, or *Astarte*. See ASTARTE.

ASTAROTH, in *Ancient Geography*, the royal residence of Og king of Bashan; whether the same with Astaroth Carnaim, is matter of doubt: if one and the same, it follows from Eusebius's account, that it lay in Bashan, and to the east of Jordan, because in the confines of Arabia.

ASTARTE, in *Pagan Mythology*, (the singular of Astaroth), a Phœnician goddess, called in Scripture the *queen of heaven*, and the *goddess of the Sidonians*.—Solomon, in compliment to one of his queens, erected an altar to her. In the reign of Ahab, Jezebel caused her worship to be performed with much pomp and ceremony: she had 400 priests; the women were employed in weaving hangings or tabernacles for her; and Jeremiah observes, that "the children gathered the wood, the fathers kindled the fire, and the women kneaded the dough, to make cakes for the queen of heaven."

ASTARTE, in *Ancient Geography*, a city on the other side Jordan; one of the names of Rabbath Ammon, in Arabia Petræa, (Stephanus).

ASTEISM, in *Rhetoric*, a genteel irony, or handsome way of deriding another. Such, e. gr: is that of Virgil:

Qui Bavium non odit, amet tua carmina, Mævi, &c.

Diomed places the characteristic of this figure, or species of irony, in that it is not gross and rustic, but ingenious and polite.

Astell.

ASTELL, MARY, an English lady who was an eminent writer, was born at Newcastle upon Tyne in the year 1668. Her father, who was a merchant, committed the education of his daughter to her uncle, who was a clergyman. Convinced of the general injury done to young ladies at that period by the deficiency of their education, he taught her the Latin and French languages, and instructed her in the principles of logic, mathematics, and natural philosophy. Having spent 20 years of her life in Newcastle, she retired to London, where she continued the pursuit of her studies; and, deeply affected with the general ignorance of her sex, she employed the first fruits of her pen to rouse them to a proper emulation, in a work, "A serious Proposal to the Ladies, wherein a Method is offered for the Improvement of their Minds," printed in 12mo. at London 1697. The chief object of that book was to erect a seminary for female education. A certain lady, supposed to be the queen, formed the design of devoting 10,000l. to this honourable purpose; but Bishop Burnet having suggested, that it would have too much the appearance of a nunnery, the design did not take effect.

Disappointed in the article of marriage with an eminent clergyman, she next wrote a book entitled "Reflections on Marriage," which was published in 1700. This lady was a zealous advocate for the religious system commonly called *orthodox*; and in politics, defended the doctrine of nonresistance. About this time she published some controversial pieces, among which are the following: "Moderation truely stated;" "A Fair Way with the Dissenters;" "An Impartial Enquiry into the causes of the Rebellion;" and "A Vindication of the Royal Martyrs;" all printed in 4to in 1704. Her most finished performance was, "The Christian Religion as professed by a Daughter of the Church of England," published in 1705, in a large octavo volume. Dr Waterland speaks of this book in very favourable terms; and such was the intrepidity of this lady, that she has attacked both Locke and Tillotson in the controversial part. In the evening of her life Mrs Astell was attacked with the severe disease of a cancer in her breast; the amputation of which she bore with singular fortitude. At the advanced age of 63 she died in the year 1731.

Mrs Astell appears to have been a woman of uncommon talents as a writer and scholar; rigid in her principles, and austere in her manners. Since a new era of female education has commenced, such an author as Mrs Astell would have attracted little notice; but at a period of society when few women could read, and scarcely any could write, it was highly honourable for a female to suggest hints, however imperfect, for the improvement of female education. It may farther be remarked, that it deserves to be mentioned, that about a century ago a lady informed the public by her pen, that "women, who ought to be retired, are for this reason designed for speculation," and that "great improvements might be made in the sciences, were not women enviously excluded from this their proper business. Deeming her time more valuable than to be wasted by trifling visitors, and abhorring the practice of of teaching servants to lie, she would humourously accost such visitors by saying, "Mrs Astell is not at home." (*Gen. Biog.*)

ASTER, STARWORT. See BOTANY *Index*.

ASTER, or *Stella Marina*, in *Zoology*. See ASTERIAS, HELMINTHOLOGY *Index*.

ASTERABAD, a province in the north-east part of Persia, having Tabristan on the east, part of the Caspian sea and part of Jorjan on the north, Korasan on the west, and Koumas on the south. It is a mountainous country, except near the banks of the rivers that almost surround it, where it is pleasant and fruitful, producing grapes of a prodigious size. In other parts the soil is sandy and barren. Asterabad is the chief town, which gives name to a gulf in the Persian sea, at the bottom of which it stands. E. Long. 54. 35. N. Lat. 36. 50.

ASTERIA, in *Zoology*, a name by which some authors have called the *falco palumbarius*, or *goshawk*. See FALCO, ORNITHOLOGY *Index*.

ASTERIA is also the name of a gem, usually called the *cat's eye*, or *oculus cati*. It is a very singular and very beautiful stone, and somewhat approaches to the nature of the opal, in having a bright included colour, which seems to be lodged deep in the body of the stone, and shifts about, as it is moved, in various directions; but it differs from the opal in all other particulars, especially in its want of the great variety of colours seen in that gem, and in its superior hardness. It is usually found between the size of a pea and the breadth of a sixpence; is almost always of a semicircular form, broad and flat at the bottom, and rounded and convex at the top; and is naturally smooth and polished. It has only two colours, a pale brown and a white; the brown seeming the ground, and the white playing about in it, as the fire colour in the opal. It is considerably hard, and will take a fine polish, but is usually worn with its native shape and smoothness. It is found in the East and West Indies, and in Europe. The island of Borneo affords some very fine ones, but they are usually small; they are very common in the sands of rivers in New Spain: and in Bohemia they are not unfrequently found immersed in the same masses of jasper with the opal.

ASTERIA is also the name of an extraneous fossil, called in English the *star-stone*. The fossils are small, short, angular, or sulcated columns, between one and two inches long, and seldom above a third of an inch in diameter: composed of several regular joints; when separated, each resembles a radiated star. They are, not without reason, supposed to be a part of some sea-fish petrified, probably the asterias or sea-star. The asteria is also called *astrites*, *astroites*, and *asteriscus*. They may be reduced to two kinds: those whose whole bodies make the form of a star; and those which in the whole are irregular, but are adorned as it were with constellations in the parts. Dr Lister, for distinction's sake, only gives the name *asteria* to the former sort, distinguishing the latter by the appellation of *astroites*; other naturalists generally use the two indiscriminately. The asteria spoken of by the ancients, appears to be of this latter kind. The quality of moving in vinegar, as if animated, is scarce perceivable in the astroites, but is signal in the asteria. The former must be broken in small pieces before it will move; but the latter will move, not only in a whole joint, but in two or three knit together. The curious frequently meet with these stones in many parts of England: at Cleydon in Oxfordshire they are found rather larger than common, but of a softer substance; for, on being left a small space of time in a strong acid, they may easily be separated at the joints in small plates.

ASTERIAS, STAR-FISH, or SEA-STAR. See HELMINTHOLOGY *Index*.

ASTERIAS, the ancient name of the bittern. See ARDEA, ORNITHOLOGY *Index*.

ASTERISK, a mark in form of a star (*), placed over a word or sentence, to refer the reader to the margin, or elsewhere, for a quotation, explanation, or the like.

ASTERIUS, or ASTURIUS, a Roman consul, in 449. We have under his name, "A Conference on the Old and New Testament," in Latin verse: in which each strophe contains, in the first verse, an historical fact in the Old Testament; and in the second, an application of that fact to some point in the New.

ASTERN, a sea-phrase, used to signify any thing at some distance behind the ship; being the opposite of AHEAD, which signifies the space before her. See AHEAD.

ASTEROPODIUM, a kind of extraneous fossil of the same substance with the asteriæ or star-stones, to which they serve as a base. See ASTERIA and STAR-STONE.

ASTHMA. See MEDICINE *Index*.

ASTI, a city of Montferrat in Italy, seated on the Tanaro, and capital of the county of the same name. It is a bishop's see, and well fortified with strong walls and deep ditches; and is divided into the city, borough, citadel, and castle. There are a great many churches and convents, as well as other handsome buildings; and its territory is well watered, abounding with groves, pleasant hills, and spacious fields. It was taken by the French in 1745, and retaken by the king of Sardinia in 1746. E. Long. 8. 15. N. Lat. 54. 50.

ASTIGI, in *Ancient Geography*, a colony, and conventus juridicus, of Bætica, surnamed *Augusta Firma*, situated on the Singulus, which falls into the Bætis; called also *Colonia Astigitana* (Pliny): Now *Ecya*, midway between Seville and Cordova. W. Long. 5°, N. Lat. 37. 20.

ASTOMI, in *Anthropology*, a people feigned without mouths. Pliny speaks of a nation of Astomi in India who lived only by the smell or effluvia of bodies taken in by the nose.

ASTORGA, a very ancient city of Spain, in the kingdom of Leon, with a bishop's see, is seated on the river Tuerta, and well fortified both by art and nature. It stands in a most agreeable plain, about 150 miles north-west of Madrid. There are excellent trouts in the river. W. Long. 6. 20. N. Lat. 42. 20.

ASTRACAN, a province of Russia, and the most easterly part of Europe; bounded on the north by Bulgaria and Baskiria; on the south by the Caspian sea; on the west, by the Volga, which divides it from the Nagayan Tartars and Don Cossacks; and on the east, by the great ridge of mountains which part it from Great Tartary. The province extends from the 46th to the 52d degree of latitude. The summer is long, and intensely hot: the winter continues about three months

Aſtracan. months ſo ſevere, that the Volga is frozen hard enough to bear loaded ſledges. The ſoil is rich and fertile; but the Tartars who inhabit it are ſtrangers to agriculture. On the weſtern and ſouthern ſides of the Volga are heaths of a prodigious extent, ſandy, deſert, and uncultivated; theſe, however, produce vaſt quantities of fine tranſparent ſalt in pits, where the ſun bakes and incruſtates it to the thickneſs of an inch on the ſurface of the water. There are pits in the neighbourhood of Aſtracan which yield this excellent ſalt in ſuch abundance, that any perſon may carry it off, paying at the rate of one farthing a pooſt, which is equal to forty pounds. The metropolis, Aſtracan, is ſituated within the boundaries of Aſia, on an iſland called *Dolgoi*, about 60 Engliſh miles above the place where the Volga diſembogues itſelf into the Caſpian ſea. The city derives its name from Hadgee Tarken, a Tartar, by whom it was founded. It was conquered by Iwan Baſilowitz, recovered by the Tartars in the year 1668, and retaken by the czar, who employed for this purpoſe a great number of flat-bottomed veſſels, in which he tranſported his forces down the Volga from Caſan.

The city of Aſtracan is about two miles and a half in circumference, ſurrounded by a brick wall, which is now in a ruinous condition: but, if we comprehend the ſuburbs, the circuit will be near five miles. The number of inhabitants amounts to 70,000, including Armenians and Tartars, as well as a few Perſians and Indians. The garriſon conſiſts of ſix regiments of the beſt Ruſſian troops, who, when this place was alarmed from the ſide of Perſia, had in the adjacent plain erected a great number of ſmall batteries, to ſcour the fields, and obſtruct the approach of the enemy. The houſes of Aſtracan are built of wood, and generally mean and inconvenient. The higher parts of the city command a proſpect of the Volga, which is here about three miles in breadth, and exhibits a noble appearance. The marſhy lands on the banks of it render the place very ſickly in the ſummer: the earth, being impregnated with ſalt, is extremely fertile, and produces abundance of fruit, the immoderate uſe of which is attended with epidemical diſtempers. Sickneſs is likewiſe the conſequence of thoſe annual changes in the atmoſphere produced by the floods in ſpring and autumn. All round the city of Aſtracan, at the diſtance of two miles, are ſeen a great number of gardens, orchards, and vineyards, producing all ſorts of herbs and roots. The grapes are counted ſo delicious, that they are preſerved in ſand, and tranſported to court by land-carriage at a prodigious expence: yet the wine of Aſtracan is very indifferent. The ſummer being generally dry, the inhabitants water their gardens by means of large wheels worked by wind or horſes, which raiſe the water to the higheſt part of the garden, from whence it runs in trenches to refreſh the roots of every ſingle tree and plant. The neighbouring country produces hares and partridges, plenty of quails in ſummer, with wild and water-fowl of all ſorts in abundance.

About ten miles below Aſtracan is a ſmall iſland called *Boſmaiſe*, on which are built large ſtorehouſes for the ſalt, which is made about twelve miles to the eaſtward, and, being brought thither in boats, is conveyed up the Volga, in order to ſupply the country as far as Moſcow and Twere. The quantity of ſalt annually dug for theſe purpoſes amounts to ſome millions of pounds, the excluſive property of which is claimed by the crown, and yields a conſiderable revenue; for the ſoldiers and bulk of the people live almoſt entirely on bread and ſalt. The neighbourhood of theſe ſalt-works is of great advantage to the fiſheries, which extend from hence to the Caſpian ſea, and reach to the ſouth-eaſt as far as Yack, and even 100 miles above Zaritzen. The principal fiſh here caught are ſturgeon and belluga. Theſe, being ſalted, are put on board of veſſels, and ſent away in the ſpring, for the uſe of the whole empire, even as far as Peterſburg: but as fiſh may be kept freſh as long as it is frozen, the winter is no ſooner ſet in, than they tranſport great quantities of it by land through all the provinces of Ruſſia. Of the roes of the fiſh called *belluga*, which are white, tranſparent, and of an agreeable flavour, the fiſhers here prepare the caviare, which is in ſo much eſteem all over Europe. Theſe fiſheries were firſt eſtabliſhed by one Tikon Demedoff, a carrier, who ſettled in this place about 60 years ago, his whole wealth conſiſting of two horſes. By dint of ſkill and induſtry, he ſoon grew the richeſt merchant in this country: but his ſucceſs became ſo alluring to the crown, that of late years it hath engroſſed ſome of the fiſheries as well as the ſalt-works.

From the latter end of July to the beginning of October, the country about Aſtracan is frequently infeſted with myriads of locuſts, which darken the air in their progreſſion from the north to the ſouthward; and, wherever they fall, conſume the whole verdure of the earth. Theſe inſects can even live for ſome time under water: for when the wind blows acroſs the Volga, vaſt numbers of them fall in cluſters, and are rolled aſhore; and their wings are no ſooner dry, than they riſe and take flight again.

Heretofore the inhabitants of Aſtracan traded to Khuva and Bokhara; but at preſent theſe branches are loſt, and their commerce is limited to Perſia and the dominions of Ruſſia. Even the trade to Perſia is much diminiſhed by the troubles of that country; nevertheleſs, the commerce of Aſtracan is ſtill conſiderable. Some years ago, the city maintained about 40 veſſels, from 100 to 200 tons burden, for the Caſpian traffic. Some of theſe belong to the government, and are commanded by a commodore, under the direction of the admiralty. This office is generally well ſtocked with naval ſtores, which are ſold occaſionally to the merchants. The trading ſhips convey proviſions to the frontier towns of Terkie and Kiſlar, ſituated on the Caſpian ſea; and tranſport merchandiſe to ſeveral parts of Perſia. The merchants of Aſtracan export to Perſia, chiefly on account of the Armenians, red leather, linens, woollen cloths, and other European manufactures. In return, they import the commodities of Perſia, particularly thoſe manufactured at Caſan; ſuch as ſilk ſaſhes intermixed with gold, for the uſe of the Poles; wrought ſilks and ſtuffs mixed with cotton; rice, cotton, rhubarb, and a ſmall quantity of other drugs; but the chief commodity is raw ſilk. The government has engroſſed the article of rhubarb, the greater part of which is brought into Ruſſia by the Tartars of Yakutſki, bordering on the eaſtern Tartars belonging to China. They travel through Siberia to Samura, thence to Caſan, and laſtly to Moſcow. The

revenue

revenue of Aſtracan is computed at 150,000 rubles, or 33,000l. ariſing chiefly from ſalt and fiſh. The city is ruled by a governor, under the check of a chancery. He is nevertheleſs arbitrary enough, and exerciſes oppreſſion with impunity. The officers of the admiralty and cuſtom-houſe having very ſmall ſalaries, are open to corruption, and extremely rapacious. At chriſtening feaſts, which are attended with great intemperance, the gueſts drink a kind of cherry-brandy out of large goblets; and every perſon invited throws a preſent of money into the bed of the mother, who ſits up with great formality to be ſaluted by the company.

The Indians have a Pagan temple at Aſtracan, in which they pay their adoration, and make offerings of fruit to a very ugly deformed idol. The prieſts of this pagod uſe incenſe, beads, cups, and proſtrations. The Tartars, on the contrary, hold idol-worſhip in the utmoſt abomination.

ASTRÆA, in *Aſtronomy*, a name which ſome give to the ſign Virgo, by others called *Erigone*, and ſometimes *Iſis*. The poets feign that juſtice quitted heaven to reſide on earth, in the golden age; but, growing weary of the iniquities of mankind, ſhe left the earth, and returned to heaven, where ſhe commenced a conſtellation of ſtars, and from her orb ſtill looks down on the ways of men.

ASTRAGAL, in *Architecture*, a little round moulding, which in the orders ſurrounds the top of the ſhaft or body of the column. It is alſo called the *talon* and *tondino*; it is uſed at the bottoms as well as tops of columns, and on other occaſions: it properly repreſents a ring, on whatever part of a column it is placed; and the original idea of it was that of a circle of iron put round the trunk of a tree, uſed to ſupport an edifice, to prevent its ſplitting. The aſtragal is often cut into beads and berries, and is uſed in the ornamented entablatures to ſeparate the ſeveral faces of the architrave.

Astragal, in *Gunnery*, a round moulding encompaſſing a cannon, about half a foot from its mouth.

ASTRAGALOMANCY, a ſpecies of divination performed by throwing ſmall pieces, with marks correſponding to the letters of the alphabet; the accidental diſpoſition of which formed the anſwer required. This kind of divination was practiſed in a temple of Hercules, in Achaia. The word is derived from ἀστραγαλος, and μαντεια, *divination*.

ASTRAGALUS, Milk-vetch, or Liquorice-vetch. See Botany *Index*.

Astragalus. See Anatomy *Index*.

ASTRANTIA, Masterwort. See Botany *Index*.

ASTRICTION, in *Law*. See Thirlage.

Astriction, among *Phyſicians*, denotes the operation of aſtringent medicines.

ASTRINGENTS, in the *Materia Medica*, ſubſtances diſtinguiſhed by a rough auſtere taſte, and changing ſolutions of iron, eſpecially thoſe made in the vitriolic acid, into a dark purple or black colour; ſuch are galls, tormentil root, biſtort root, balauſtines, terra japonica, acacia, &c. See Materia Medica *Index*.

ASTROGNOSIA, the ſcience of the fixed ſtars, or the knowledge of their names, conſtellations, magnitudes, &c.

ASTROITES, or star-stone, in *Natural Hiſtory*. See Asteria and Star-Stone.

ASTROLABE, the name for a ſtereographic projection of the ſphere, either upon the plane of the equator, the eye being ſuppoſed to be in the pole of the world; or upon the plane of the meridian, when the eye is ſuppoſed in the point of the interſection of the equinoctial and horizon.

Astrolabe is alſo the name of an inſtrument formerly uſed for taking the altitude of the ſun or ſtars at ſea.

Astrolabe, among the *Ancients*, was the ſame as our armillary ſphere.

ASTROLOGY, a conjectural ſcience, which teaches to judge of the effects and influences of the ſtars, and to foretel future events by the ſituation and different aſpects of the heavenly bodies.

This ſcience has been divided into two branches, *natural* and *judiciary*. To the former belongs the predicting of natural effects; as, the changes of weather, winds, ſtorms, hurricanes, thunder, floods, earthquakes, &c. This art properly belongs to natural philoſophy; and is only to be deduced *à poſteriori*, from phenomena and obſervations. Judiciary or judicial aſtrology, is that which pretends to foretel moral events; i. e. ſuch as have a dependency on the free will and agency of man; as if they were directed by the ſtars. This art, which owed its origin to the practices of knavery on credulity, is now univerſally exploded by the intelligent part of mankind.

The profeſſors of this kind of aſtrology maintain, "That the heavens are one great volume or book, wherein God has written the hiſtory of the world; and in which every man may read his own fortune, and the tranſactions of his time. The art, ſay they, had its riſe from the ſame hands as aſtronomy itſelf: while the ancient Aſſyrians, whoſe ſerene unclouded ſky favoured their celeſtial obſervations, were intent on tracing the paths and periods of the heavenly bodies, they diſcovered a conſtant ſettled relation or analogy between them and things below; and hence were led to conclude theſe to be the Parcæ, the Deſtinies, ſo much talked of, which preſide at our births, and diſpoſe of our future fate.

"The laws therefore of this relation being aſcertained by a ſeries of obſervations, and the ſhare each planet has therein; by knowing the preciſe time of any perſon's nativity, they were enabled, from their knowledge in aſtronomy, to erect a ſcheme or horoſcope of the ſituation of the planets at this point of time; and, hence, by conſidering their degrees of power and influence, and how each was either ſtrengthened or tempered by ſome other, to compute what muſt be the reſult thereof."

Thus the aſtrologers.—But the chief province now remaining to the modern profeſſors, is the making of calendars or almanacks.

Judicial aſtrology is commonly ſaid to have been invented in Chaldea, and thence tranſmitted to the Egyptians, Greeks, and Romans; though ſome will have it of Egyptian origin, and aſcribe the invention to Cham. But it is to the Arabs that we owe it. At Rome the

Astrology. the people were so infatuated with it, that the astrologers, or, as they were then called, the *mathematicians*, maintained their ground in spite of all the edicts of the emperors to expel them out of the city. See GENETHLIACI.

Add, that the Bramins, who introduced and practised this art among the Indians, have hereby made themselves the arbiters of good and evil hours, which gives them great authority: they are consulted as oracles; and they have taken care never to sell their answers but at good rates.

The same superstition has prevailed in more modern ages and nations. The French historians remark, that in the time of Queen Catharine de Medicis, astrology was in so much vogue, that the most inconsiderable thing was not to be done without consulting the stars. And in the reigns of King Henry III. and IV. of France, the predictions of astrologers were the common theme of the court conversation. This predominant humour in that court was well rallied by Barclay, in his *Argenis*, lib. ii. on occasion of an astrologer, who had undertaken to instruct King Henry in the event of a war then threatened by the faction of the Guises.

Astronium || Astronomical Sector.

ASTRONIUM. See BOTANY *Index*.

ASTRONOMICAL, something relating to ASTRONOMY.

ASTRONOMICAL Calendar, an instrument engraved on copperplates, printed on paper, and pasted on a board, with a brass slider carrying a hair: it shows by inspection the sun's meridian altitude, right ascension, declination, rising, setting, amplitude, &c. to a greater degree of exactness than the common globes.

ASTRONOMICAL Sector, a very useful mathematical instrument, made by the late ingenious Mr Graham; a description of which is given in the course of the following article.

ASTRONOMY.

ASTRONOMY is that science which treats of the motions of the heavenly bodies, and explains the laws by which these motions are regulated.

It is the most sublime and the most perfect of all the sciences. No subject has been longer studied, or has made greater progress. There is a vast interval between the rude observations of the earlier astronomers and the precision and general views which direct our present observers. To ascertain the apparent motions of the heavenly bodies was a difficult task, and required the united observations of ages. To unravel these intricate mazes, and detect and demonstrate the real motions, demanded the most patient perseverance, judgment, and dexterity. To ascertain the laws of these motions, and to resolve the whole of them into one general fact, required the exertions of a sagacity scarcely to be expected in human nature. Yet all this has been accomplished; and even the most minute movement of the heavenly bodies has been shewn to depend upon the same general law with all the rest, and even to be a consequence of that law. Astronomy, therefore, is highly interesting, were it only because it exhibits the finest instance of the length that the reasoning faculties can go. It is the triumph of philosophy and of human nature. But this is not all. It has conferred upon mankind the greatest benefits, and may truly be considered as the grand improver and conductor of navigation.

The following treatise will be divided into four parts. In the *first* part, we shall give a sketch of the history of astronomy; in the *second*, we shall treat of the apparent motions of the heavenly bodies; in the *third*, of their real motions; and in the *fourth*, of gravitation, or of that general fact to which all their motions may be referred, and from which they proceed.

PART I. HISTORY OF ASTRONOMY.

History.

THE antiquity of this science may be gathered from what was spoken by the Deity at the time of creating the celestial luminaries, "Let them be for signs and seasons," &c. whence it is thought probable that the human race never existed without some knowledge of astronomy among them. Indeed, besides the motives of mere curiosity, which of themselves may be supposed to have excited people to a contemplation of the glorious celestial canopy, as far as that was possible, it is easily to be seen that some parts of the science answer such essential purposes to mankind, that they could not possibly be dispensed with.

1 Astronomy supposed to be understood by Adam and the Antediluvians.

By some of the Jewish rabbins, Adam, in his state of innocence, is supposed to have been endowed with a knowledge of the nature, influence, and uses of the heavenly bodies; and Josephus ascribes to Seth and his posterity an extensive knowledge of astronomy. But whatever may be in this, the long lives of the Antediluvians certainly afforded such an excellent opportunity for observing the celestial bodies, that we cannot but suppose the science of astronomy to have been considerably advanced before the flood. Josephus says, that longevity was bestowed upon them for the very purpose of improving the sciences of geometry and astronomy. The latter could not be learned in less than 600 years: "for that period (says he) is the *grand year*." By which it is supposed he meant the period wherein the sun and moon came again into the same situation as they were in the beginning thereof, with regard to the nodes, apogee of the moon, &c. "This period (says Cassini), whereof we find no intimation in any monument of any other nation, is the finest period that ever was invented: for it brings out the solar year more exactly than that of Hipparchus and Ptolemy; and the lunar month within about one second of what is determined by modern astronomers. If the Antediluvians

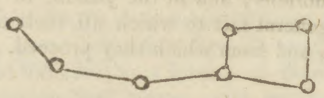
vians had ſuch a period of 600 years, they muſt have known the motions of the ſun and moon more exactly than their deſcendants knew them ſome ages after the flood."

2 Aſtronomical knowledge of the Chineſe.

On the building of the tower of Babel, Noah is ſuppoſed to have retired with his children born after the flood, to the north-eaſtern part of Aſia, where his deſcendants peopled the vaſt empire of China. "This (ſays Dr Long) may perhaps account for the Chineſe having ſo early cultivated the ſtudy of aſtronomy; their being ſo well ſettled in an admirable police, and continuing ſo many hundred years as they did in the worſhip of the true God." The vanity of that people indeed has prompted them to pretend a knowledge of aſtronomy almoſt as early as the flood itſelf. Some of the Jeſuit miſſionaries have found traditional accounts among the Chineſe, of their having been taught this ſcience by their firſt emperor Fo-hi, ſuppoſed to be Noah; and Kempfer informs us, that this perſonage diſcovered the motions of the heavens, divided time into years and months, and invented the twelve ſigns into which they divide the zodiac, which they diſtinguiſh by the following names. 1. The mouſe. 2. The ox or cow.

3 Their names for the ſigns of the zodiac.

3. The tiger. 4. The hare. 5. The dragon. 6. The ſerpent. 7. The horſe. 8. The ſheep. 9. The monkey. 10. The cock or hen. 11. The dog; and, 12. The boar. They divide the heavens into 28 conſtellations, four of which are aſſigned to each of the ſeven planets; ſo that the year always begins with the ſame planet; and their conſtellations anſwer to the 28 manſions of the moon uſed by the Arabian aſtronomers. Theſe conſtellations, in the Chineſe books of aſtronomy, are not marked by the figures of animals, as was in uſe among the Greeks, and from them derived to the other European nations, but by connecting the ſtars by ſtraight lines: and Dr Long informs us, that in a Chineſe book in thin 4to, ſhown him by Lord Pembroke, the ſtars were repreſented by ſmall circles joined by lines; ſo that the Great Bear would be marked thus,



To the emperor Hong-ti, the grandſon of Noah, they attribute the diſcovery of the pole-ſtar, the invention of the mariner's compaſs, of a period of 60 years, and ſome kind of ſphere. This extraordinary antiquity, however, is with good reaſon ſuſpected, as is likewiſe their knowledge in the calculation of eclipſes; of which Du Halde aſſures us, that 36 are recorded by Confucius himſelf, who lived 551 years before Chriſt; and P. Trigault, who went to China in 1619, and read more than 100 volumes of their annals, ſays, "It is certain that the Chineſe began to make aſtronomical obſervations ſoon after the flood; that they have obſerved a great number of eclipſes, in which they have noted down the hour, day, month, and year, when they happened, but neither the duration nor the quantity; and that theſe eclipſes have been made uſe of for regulating their chronology."

"But out of this abundance (ſays Dr Long), it is much to be regretted, that ſo very few of their obſervations have been particularized; for beſide what has been mentioned above, we meet with no very ancient obſervations of the Chineſe, except a winter ſolſtice in the year 1111, and a ſummer ſolſtice in the year 882, before Chriſt. Martini indeed ſpeaks of a ſummer ſolſtice 2342 years before that period. But M. Caſſini, who calculated it, found that there muſt have been an error in the Chineſe computation of 500 years at leaſt. An error of equal magnitude appears to have been committed in the conjunction of the five planets, which it is pretended they obſerved between the years 2513 and 2435 before Chriſt. In ſhort, ſome have ſuppoſed, that none of theſe are real obſervations, but the reſult of bungling calculations; and it has been hinted, but ſurely on too ſlight a foundation, that even thoſe good fathers themſelves were greatly to be ſuſpected. But let us come to things which are not conteſted.

"P. Gaubil informs us, that at leaſt 120 years before Chriſt, the Chineſe had determined by obſervation the number and extent of their conſtellations as they now ſtand; the ſituation of the fixed ſtars with reſpect to the equinoctial and ſolſtitial points; and the obliquity of the ecliptic. He farther ſays, he cannot tell by what means it is that they foretel eclipſes: but this is certain, that the theory by which they do predict them was ſettled about the ſame time; and that they were acquainted with the true length of the ſolar year, the method of obſerving meridian altitudes of the ſun by the ſhadow of a gnomon, and of learning from thence his declination and the height of the pole, long before. We learn, moreover, from the ſame miſſionary, that there are yet remaining among them ſome treatiſes of aſtronomy, which were written about 200 years before Chriſt; from which it appears, that the Chineſe had known the daily motion of the ſun and moon, and the times of the revolutions of the planets, many years before that period.

"We are informed by Du Halde, that, in the province of Honan, and city Teng-foang, which is nearly in the middle of China, there is a tower, on the top of which it is ſaid that *Tcheou-cong*, the moſt ſkilful aſtronomer that ever China produced, made his obſervations. He lived 1200 years before Ptolemy, or more than 1000 years before Chriſt, and paſſed whole nights in obſerving the celeſtial bodies and arranging them into conſtellations. He uſed a very large braſs table placed perfectly horizontal, on which was fixed a long upright plate of the ſame metal, both of which were divided into degrees, &c. By theſe he marked the meridian altitudes; and from thence derived the times of the ſolſtices, which were their principal epocha."

Dr Long repreſents the ſtate of aſtronomy in China as at preſent very low; occaſioned, he ſays, principally by the barbarous decree of one of their emperors *, to have all the books in the empire burnt, excepting ſuch as related to agriculture and medicine. We are informed, however, by the Abbe Groſier, in his deſcription of China, that aſtronomy is cultivated in Pekin in the ſame manner as in moſt of the capital cities of Europe. A particular tribunal is eſtabliſhed there, the juriſdiction of which extends to every thing relating to the obſervation of celeſtial phenomena. Its members are, an inſpector; two preſidents, one of them a Tartar and the other a Chineſe; and a certain number of mandarins who perform the duty of aſſeſſors; but for near a century and a half the place of the Chineſe preſident has been filled by an European. Since that time particular attention has been paid to the

* See *China*.

History. the inftruction of the aftronomical pupils; and the prefidents have always confidered it as their duty to make them acquainted with the fyftem and method of calculation made ufe of in Europe. Thus two-thirds of the aftronomical pupils, maintained at the emperor's expence, in all about 200, have a tolerable notion of the ftate of the heavens, and underftand calculation fo well as to be able to compofe ephemerides of fufficient exactnefs. The miffionaries have never been the authors of any of thefe ephemerides: their employment is to revife the labours of the Chinefe mathematicians, verify their calculations, and correct any errors into which they have fallen. The Portuguefe miffion ftill continues to furnifh aftronomers for the academy, as it did at the firft.

The aftronomical tribunal is fubordinate to that of ceremonies. When an eclipfe is to be obferved, information muft be given to the emperor of the day and hour, the part of the heavens where it will be, &c. and this intelligence muft be communicated fome months before it happen; the eclipfe muft alfo be calculated for the longitude and latitude of the capital city of every province of the empire. Thefe obfervations, as well as the diagram which reprefents the eclipfe, are preferved by the tribunal of ceremonies, and another called the *calao*, by whom it is tranfmitted to the different provinces and cities of the empire. Some days before the eclipfe, the tribunal of ceremonies caufes to be fixed up in a public place, in large characters, the hour and minute when the eclipfe will commence, the quarter of the heavens in which it will be vifible, with the other particulars relating to it. The mandarins are fummoned to appear in ftate at the tribunal of aftronomy, and to wait there for the moment in which the phenomenon will take place. Each of them carries in his hand a fheet of paper, containing a figure of the eclipfe and every circumftance attending it. As foon as the obfervation begins to take place, they throw themfelves on their knees, and knock their heads againft the earth, and a horrid noife of drums and cymbals immediately commences throughout the whole city: a ceremony proceeding from an ancient fuperftitious notion, that by fuch a noife they prevented the luminary from being devoured by the celeftial dragon; and though this notion is now exploded in China, as well as everywhere elfe, fuch is the attachment of the people to ancient cuftoms, that the ceremonial is ftill preferved. While the mandarins thus remain proftrated in the court, others, ftationed on the obfervatory, examine, with all the attention poffible, the beginning middle, and end of the eclipfe, comparing what they obferve with the figure and calculations given. They then write down their obfervations, affix their feal to them, and tranfmit them to the emperor; who, on his part, has been no lefs affiduous to obferve the eclipfe with accuracy. A ceremonial of this kind is obferved throughout the whple empire.

The Japanefe, Siamefe, and inhabitants of the Mogul's empire, have alfo, from time immemorial, been acquainted with aftronomy; and the celebrated obfervatory at BENARES, is a monument both of the ingenuity of the people and of their fkill in this fcience.

4 Indian aftronomy.

Mr Bailly has been at great pains to inveftigate the progrefs of the Indians in aftronomical knowledge, and gives a fplendid account of their proficiency in the fcience, as well as of the antiquity of their obfervations. He has examined and compared four different aftronomical tables of the Indian philofophers. 1. Of the Siamefe, explained by M. Caffini in 1689. 2. Thofe brought from India by M. le Gentil of the Academy of Sciences. 3. and 4. Two other manufcript tables found among the papers of the late M. de Lifle. All of thefe tables have different epochs, and differ in form, being alfo conftructed in different ways; yet they all evidently belong to the fame aftronomical fyftem: the motions attributed to the fun and the moon are the fame, and the different epochs are fo well connected by the mean motions, as to demonftrate that they had only one, whence the others were derived by calculation. The meridians are all referred to that of Benares above-mentioned. The fundamental epoch of the Indian aftronomy is a conjunction of the fun and moon, which took place at no lefs a diftance of time than 3102 years before the Chriftian era. Mr Bailly informs us, that, according to our moft accurate aftronomical tables, a conjunction of the fun and moon actually did happen at that time. But though the bramins pretend to have afcertained the places of the two luminaries at that time, it is impoffible for us at this time to judge of the truth of their affertions, by reafon of the unequal motion of the moon; which, as fhall afterwards be more particularly taken notice of, now performs its revolution in a fhorter time than formerly.

Our author informs us, that the Indians at prefent calculate eclipfes by the mean motions of the fun and moon obferved 5000 years ago; and with regard to the folar motion, their accuracy far exceeds that of the beft Grecian aftronomers. The lunar motions they had alfo fettled, by computing the fpace through which that luminary had paffed in 1,600,984 days, or fomewhat more than 4383 years. They alfo make ufe of the cycle of 19 years attributed by the Greeks to Meton; and their theory of the planets is much better than that of Ptolemy, as they do not fuppofe the earth to be the centre of the celeftial motions, and they believe that Mercury and Venus turn round the fun. Mr Bailly alfo informs us, that their aftronomy agrees with the moft modern difcoveries of the decreafe of the obliquity of the ecliptic, the acceleration of the motion of the equinoctial points, with many other particulars too tedious to enumerate in this place.

5 Aftronomy of the Americans.

It appears alfo, that even the Americans were not unacquainted with aftronomy, though they made ufe only of the folar, and not of the lunar motions, in their divifion of time. The Mexicans have had a ftrange predilection for the number 13. Their fhorteft periods confifted of 13 days; their cycle of 13 months, each containing 20 days; and their century of four periods of 13 years each. This exceffive veneration for the number 13, according to Siguenza, arofe from its being fuppofed the number of their greater gods. What is very furprifing, though afferted as a fact by Abbé Clavigero, is that having difcovered the excefs of a few hours in the folar above the civil year, they made ufe of intercalary days, to bring them to an equality: but with this difference in regard to the method eftablifhed by Julius Cæfar in the Roman calendar, that they did not interpofe a day every four years, but 13 days (making ufe here even of this favourite num-

 ber)

ber) every 52 years, which produces the ſame regulation of time.

6 Of the Chaldeans and Egyptians.

Among thoſe nations who firſt began to make any figure in ancient hiſtory, we find the Chaldeans and Egyptians moſt remarkable for their aſtronomical knowledge. Both of them pretended to an extravagant antiquity, and diſputed the honour of having been the firſt cultivators of the ſcience. The Chaldeans boaſted of their temple of Belus; and of Zoroaſter, whom they placed 5000 years before the deſtruction of Troy: the Egyptians boaſted of their colleges of prieſts, where aſtronomy was taught; and of the monument of Oſymandyas, in which we are told was a golden circle 365 cubits in circumference and one cubit thick. The upper face was divided into 365 equal parts, anſwering to the days of the year; and on every diviſion were written the name of the day, and the heliacal riſing of the ſeveral ſtars for that day, with the prognoſtications from their riſing, principally, as Long conjectures, for the weather.

The Chaldeans certainly began to make obſervations very ſoon after the confuſion of languages; for when Alexander the Great took Babylon, Calliſthenes, by his order, inquired after the aſtronomical obſervations recorded in that city, and obtained them for 1903 years back. Nothing, however, now remains of the Chaldean aſtronomy, excepting ſome periods of years which they had formed for the more ready computation of the heavenly bodies. But though they muſt have laboured under great diſadvantages, for want of proper inſtruments, in thoſe early ages, Gemina, as quoted by Petarius in his Uranologion, informs us, that they had determined, with tolerable exactneſs, the length both of a ſynodical and periodical month. They had alſo diſcovered, that the motion of the moon was not uniform, and even attempted to aſſign thoſe parts of her orbit in which it was quicker or ſlower. Ptolemy alſo aſſures us, that they were not unacquainted with the motion of the moon's nodes, and that of her apogee, ſuppoſing that the former made a complete revolution in $6585\frac{1}{3}$ days, or 18 years 15 days and 8 hours; which period, containing 223 complete lunations, is called the Chaldean *Saros*. The ſame author alſo gives us, from Hipparchus, ſeveral obſervations of lunar eclipſes which had been made at Babylon about 720 years before Chriſt; but though he might very probably meet with many of a more ancient date, it was impoſſible to mention them particularly, on account of the imperfect ſtate of the Chaldean chronology, which commenced only with the era of Nabonaſſar, 747 years before Chriſt. Ariſtotle likewiſe informs us, that they had many obſervations of the occultations of fixed ſtars and planets by the moon; and from hence, by a very natural and eaſy inference, they were led to conclude that the eclipſes of the ſun were occaſioned alſo by the moon, eſpecially as they conſtantly happened when the latter was in the ſame part of the heavens with the ſun. They had alſo a conſiderable ſhare in arranging the ſtars into conſtellations. Nor had the comets, by which aſtronomers in all ages have been ſo much perplexed, eſcaped their obſervation: for both Diodorus Siculus and Appollinus Myndius, in Seneca, inform us, that many of the Chaldeans held theſe to be laſting bodies, which have ſtated revolutions as well as the planets, but in orbits vaſtly more extenſive; on which account they are only ſeen by us while near the earth, but diſappear again when they go into the higher regions. Others of them were of opinion, that the comets were only meteors raiſed very high in the air, which blaze for a while, and diſappear when the matter of which they conſiſt is conſumed or diſperſed. Dialling was alſo known among them long before the Greeks were acquainted with any ſuch thing.

It is evident, indeed, that the countries both of Chaldea and Egypt were exceedingly proper for aſtronomical obſervations, on account of the general purity and ſerenity of the air. The tower or temple of Belus, which was of an extraordinary height, with ſtairs winding round it up to the top, is ſuppoſed to have been an aſtronomical obſervatory; and the lofty pyramids of Egypt, whatever they were originally deſigned for, might poſſibly anſwer the ſame purpoſe. Indeed theſe very ancient monuments ſhow the ſkill of this people in practical aſtronomy, as they are all ſituated with their four fronts exactly facing the cardinal points. Herodotus aſcribes the Egyptian knowledge in aſtronomy to Seſoſtris, whom Sir Iſaac Newton makes contemporary with Solomon: but if this was the caſe, he could not be the inſtructor of the Egyptians in aſtronomical matters, ſince we find that Moſes, who lived 500 years before Solomon, was ſkilled in all the wiſdom of the Egyptians, in which we are undoubtedly to include aſtronomy.

From the teſtimony of ſome ancient authors, we learn that they believed the earth to be ſpherical, that they knew the moon was eclipſed by falling into its ſhadow, and that they made their obſervations with the greateſt exactneſs. They even pretended to foretel the appearance of comets, as well as earthquakes and inundations; which extraordinary knowledge is likewiſe aſcribed to the Chaldeans. They attempted to meaſure the magnitude of the earth and the ſun; but the methods they took to find out the latter were very erroneous. It does not indeed appear with certainty that they had any knowledge of the true ſyſtem of the univerſe; and by the time of the emperor Auguſtus, their aſtronomical knowledge was entirely loſt.

7 Of the Phenicians.

From Chaldea the ſcience of aſtronomy moſt probably paſſed into Phenicia; though ſome are of opinion that the Phenicians derived their knowledge of this ſcience from the Egyptians. They ſeem, however, to have been the firſt who applied aſtronomy to the purpoſes of navigation; by which they became maſters of the ſea, and of almoſt all the commerce in the world. They became adventurous in their voyages, ſteering their ſhips by one of the ſtars of the Little Bear; which being near the immoveable point of the heavens called the *Pole*, is the moſt proper guide in navigation. Other nations made their obſervations by the Great Bear; which being too diſtant from the pole could not guide them in long voyages; and for this reaſon they never durſt venture far from the coaſts.

8 Aſtronomy of the Greeks.

The firſt origin of aſtronomical knowledge among the Greeks is unknown. Sir Iſaac Newton ſuppoſes that moſt of the conſtellations were invented about the time of the Argonautic expedition: but Dr Long is of opinion that many of them muſt have been of a much older date; and that the ſhepherds, who were certainly

History. certainly the first observers, gave names to them according to their fancy; from whence the poets invented many of their fables. Several of the constellations are mentioned by Hesiod and Homer, the two most ancient writers among the Greeks, who lived about 870 years before Christ; Hesiod desiring the farmer to regulate the time of sowing and harvest by the rising and setting of the Pleiades; and Homer informing us, that observations from the Pleiades, Orion, and Arcturus, were used in navigation. Their astronomical knowledge, however, was greatly improved by Thales the Milesian, who travelled into Egypt, and brought from thence the first principles of the science. He is said to have determined the height of the pyramids by measuring their shadows at the time the sun was 45 degrees high, and when of consequence the lengths of the shadows of objects are equal to their perpendicular heights. But his reputation was raised to the highest pitch among his countrymen, by the prediction of an eclipse, which happened just at the time that the armies of Alyattes king of Lydia, and Cyaxares the Mede, were about to engage; and being regarded as an evil omen by both parties, inclined them to peace. To him Callimachus attributes the forming of the constellation of the Little Bear; the knowledge of which he certainly introduced into Greece. He also taught the true length of the year; determined the cosmical setting of the Pleiades in his time to have been 25 days after the autumnal equinox; divided the earth into five zones by means of the polar circles and tropics; taught the obliquity of the ecliptic; and showed that the equinoctial is cut by the meridians at right angles, all of which intersect each other at the poles. He is also said to have observed the exact time of the solstices, and from thence to have deduced the true length of the solar year; to have observed eclipses of the sun and moon; and to have taught that the moon had no light but what she borrowed from the sun. According to Stanley, he also determined the diameter of the sun to be one-720th part of his annual orbit. "But (says Dr Long) these things should be received with caution. There are some reasons which might be assigned for supposing that the knowledge of Thales in these matters was much more circumscribed: and indeed it is not unreasonable to suppose, that that veneration for the ancients which leads authors to write professedly on the history of ancient times, may have induced them to ascribe full as much knowledge to them who lived in them as was really their due."

9 Improved by Thales.

10 By Anaximander, &c.

The successors of Thales, Anaximander, Anaximenes, and Anaxagoras, contributed considerably to the advancement of astronomy. The first is said to have invented or introduced the gnomon into Greece; to have observed the obliquity of the ecliptic; and taught that the earth was spherical, and the centre of the universe, and that the sun was not less than it. He is also said to have made the first globe, and to have set up a sun-dial at Lacedemon, which is the first we hear of among the Greeks; though some are of opinion that these pieces of knowledge were brought from Babylon by Pherycides, a cotemporary of Anaximander. Anaxagoras also predicted an eclipse which happened in the fifth year of the Peloponnesian war; and taught that the moon was habitable, consisting of hills, valleys, and waters, like the earth. His cotemporary Pythagoras, however, greatly improved not only astronomy and mathematics, but every other branch of philosophy. He taught that the universe was composed of four elements, and that it had the sun in the centre; that the earth was round, and had antipodes; and that the moon reflected the rays of the sun; that the stars were worlds, containing earth, air, and ether; that the moon was inhabited like the earth; and that the comets were a kind of wandering stars, disappearing in the superior parts of their orbits, and becoming visible only in the lower parts of them. The white colour of the milky-way he ascribed to the brightness of a great number of small stars; and he supposed the distances of the moon and planets from the earth to be in certain harmonic proportions to one another. He is said also to have exhibited the oblique course of the sun in the ecliptic and the tropical circles, by means of an artificial sphere; and he first taught that the planet Venus is both the evening and morning star. This philosopher is said to have been taken prisoner by Cambyses, and thus to have become acquainted with all the mysteries of the Persian magi; after which he settled at Crotona in Italy, and founded the Italian sect.

History. 11 Doctrines of Pythagoras.

About 440 years before the Christian era, Philolaus, a celebrated Pythagorean, asserted the annual motion of the earth round the sun; and soon after Hicetas, a Syracusan, taught its diurnal motion on its own axis. About this time also flourished Meton and Euctemon at Athens, who took an exact observation of the summer solstice 432 years before Christ; which is the oldest observation of the kind we have, excepting what is delivered by the Chinese. Meton is said to have composed a cycle of 19 years, which still bears his name; and he marked the risings and settings of the stars, and what seasons they pointed out: in all which he was assisted by his companion Euctemon. The science, however, was obscured by Plato and Aristotle, who embraced the system afterwards called the *Ptolemaic*, which places the earth in the centre of the universe.

Eudoxus the Cnidian was a cotemporary with Aristotle, though considerably older, and is greatly celebrated on account of his skill in astronomy. He was the first who introduced geometry into the science, and he is supposed to be the inventor of many propositions attributed to Euclid. Having travelled into Egypt in the earlier part of his life, and obtained a recommendation from Agesilaus to Nectanebus king of Egypt, he, by his means, got access to the priests, who had the knowledge of astronomy entirely among them, after which he taught in Asia and Italy. Seneca tells us that he brought the knowledge of the planetary motions from Egypt into Greece; and Archimedes, that he believed the diameter of the sun to be nine times that of the moon. He was also well acquainted with the method of drawing a sun-dial upon a plane; from whence it may be inferred that he understood the doctrine of the projection of the sphere: yet, notwithstanding what has been said concerning the observations of Eudoxus, it is not certain that his sphere was not taken from one much more ancient, ascribed to Chiron the Centaur. The reason given for this supposition is, that had the places of the stars been taken from his own observations, the constellations must have been half a sign farther advanced than they are said to be in his writings.

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Soon after Eudoxus, Calippus flouriſhed, whoſe ſyſtem of the celeſtial ſphere is mentioned by Ariſtotle; but he is better known from a period of 76 years, containing four corrected metonic periods, and which had its beginning at the ſummer ſolſtice in the year 330 before Chriſt. But about this time, or rather earlier, the Greeks having begun to plant colonies in Italy, Gaul, and Egypt, theſe became acquainted with the Pythagorean ſyſtem, and the notions of the ancient Druids concerning aſtronomy. Julius Cæſar informs us, that the latter were ſkilled in this ſcience; and that the Gauls in general were able ſailors, which at that time they could not be without a competent knowledge of aſtronomy: and it is related of Pythoas, who lived at Marſeilles in the time of Alexander the Great, that he obſerved the altitude of the ſun at the ſummer ſolſtice by means of a gnomon. He is alſo ſaid to have travelled as far as Thulè to ſettle the climates.

12 State of aſtronomy in Egypt after the death of Alexander.

After the death of Alexander the Great, ſciences flouriſhed in Egypt more than in any other part of the world; and a famous ſchool was ſet up at Alexandria under the auſpices of Ptolemy Philadelphus, a prince inſtructed in all kinds of learning, and the patron of all thoſe who cultivated them; and this ſchool continued to be the ſeminary of all kinds of literature, till the invaſion of the Saracens in 650. Timocharis and Aryſtillus, who firſt cultivated the aſtronomical ſcience in this ſchool, began to put it on a new footing; being much more careful in their obſervations, and exact in noting down the times when they were made, than their predeceſſors. Ptolemy aſſures us, that Hipparchus made uſe of their obſervations, by means of which he diſcovered that the ſtars had a motion in longitude of about one degree in an hundred years; and he cites many of their obſervations, the oldeſt of which is before the erection of this ſchool, in the year 295, when the moon juſt touched the northern ſtar in the forehead of the Scorpion; and the laſt of them was in the 13th year of Philadelphus, when Venus hid the former ſtar of the four in the left wing of Virgo.

From this time the ſcience of aſtronomy continued greatly to advance. Ariſtarchus, who lived about 270 years before Chriſt, ſtrenuouſly aſſerted the Pythagorean ſyſtem, and gave a method of determining the diſtance of the ſun by the moon's dichotomy. Eratoſthenes, born at Cyrene in 271 B. C. determined the meaſure of a great circle of the earth by means of a gnomon. His reputation was ſo great, that he was invited from Athens to Alexandria by Ptolemy Euergetes, and made by him keeper of the royal library at that place. At his inſtigation the ſame prince ſet up thoſe armillas or ſpheres, which Hipparchus and Ptolemy the aſtronomer afterwards employed ſo ſucceſsfully in obſerving the heavens. He alſo found the diſtance between the tropics to be eleven ſuch parts as the whole meridian contains eighty-three. About the ſame time Beroſus, a native of Chaldea, flouriſhed at Athens. He is by ſome ſaid to have brought many obſervations from Babylon, which are aſcribed to the Greeks; while others contend, that the latter owe little or nothing of their aſtronomical knowledge to the Babylonians. The celebrated Archimedes, who next to Sir Iſaac Newton holds the firſt place among mathematicians, was nothing inferior as an aſtronomer to what he was as a geometrician. He determined the diſtance of the moon from the earth, of Mercury from the moon, of Venus from Mercury, of the ſun from Venus, of Mars from the ſun, of Jupiter from Mars, and of Saturn from Jupiter; as likewiſe the diſtance of the fixed ſtars from the orbit of Saturn. That he made aſtronomical obſervations, is not to be doubted; and it appears from an epigram of the poet Claudian, that he invented a kind of planetarium, or orrery, to repreſent the phenomena and motions of the heavenly bodies.

13 Diſcoveries of Archimedes.

14 Of Hipparchus.

Hipparchus was the firſt who applied himſelf to the ſtudy of every part of aſtronomy, his predeceſſors having chiefly conſidered the motions and magnitudes of the ſun and moon. Ptolemy alſo informs us, that he firſt diſcovered the orbits of the planets to be eccentric, and on this hypotheſis wrote a book againſt Eudoxus and Calippus. He gives many of his obſervations; and ſays, that by comparing one of his with another made by Ariſtarchus 145 years before, he was enabled to determine the length of the year with great preciſion. Hipparchus alſo firſt found out the anticipation of the moon's nodes, the eccentricity of her orbit, and that ſhe moved ſlower in her apogee than in her perigee. He collected the accounts of ſuch ancient eclipſes as had been obſerved by the Chaldeans and Egyptians. He formed hypotheſes concerning the celeſtial motions, and conſtructed tables of thoſe of the ſun and moon, and would have done the ſame with thoſe of the other planets if he could have found ancient obſervations ſufficient for the purpoſe; but, theſe being wanting, he was obliged to content himſelf with collecting fit obſervations for that purpoſe, and endeavouring to form theories of the five planets. By comparing his own obſervations on the Spica Virginis with thoſe of Timochares at Alexandria made 100 years before, he diſcovered that the fixed ſtars changed their places, and had a ſlow motion of their own from weſt to eaſt. He corrected the Calippic period, and pointed out ſome errors in the method laid down by Eratoſthenes for meaſuring the circumference of the earth. By means of geometry, which was now greatly improved, he was enabled to attempt the calculation of the ſun's diſtance in a more correct manner than any of his predeceſſors; but unhappily it required ſo much accuracy in obſervation as was found impracticable. His greateſt work, however, was his catalogue of the fixed ſtars, which he was induced to attempt by the appearance of a new ſtar. The catalogue is preſerved by Ptolemy, and contains the longitudes and latitudes of 1022 ſtars, with their apparent magnitudes. He wrote alſo concerning the intervals between eclipſes both ſolar and lunar, and is ſaid to have calculated all that were to happen for no leſs than 600 years from his time.

15 Makes the firſt catalogue of fixed ſtars.

16 Syſtem of Ptolemy.

Little progreſs was made in aſtronomy from the time of Hipparchus to that of Ptolemy, who flouriſhed in the firſt century. The principles on which his ſyſtem is built are indeed erroneous; but his work will always be valuable on account of the number of ancient obſervations it contains. It was firſt tranſlated out of the Greek into Arabic in the year 827, and into Latin from the Arabic in 1230. The Greek original was unknown in Europe till the beginning of the 15th century, History. century, when it was brought from Constantinople, then taken by the Turks, by George a monk of Trapezond, who translated it into Latin. Various editions were afterwards published; but little or no improvement was made by the Greeks in this science.

17 Astronomy of the Arabians.

During the long period from the year 800 to the beginning of the 14th century, the western parts of Europe were immersed in deep ignorance and barbarity. However, several learned men arose among the Arabians. The caliph Al Mansur was the first who introduced a taste for the sciences in his empire. His grandson Al Mamun, who ascended the throne in 814, was a great encourager of the sciences, and devoted much of his own time to the study of them. He made many astronomical observations himself, and determined the obliquity of the ecliptic to be 23° 35′. He employed many able mechanics in constructing proper instruments, which he made use of for his observations; and under his auspices a degree of the earth was measured a second time in the plain of Singar, on the border of the Red sea. From this time astronomy was studiously cultivated by the Arabians; and Elements of Astronomy were written by Alferganus, who was partly cotemporary with the caliph Al Mamun. But the most celebrated of all their astronomers is Albategnius, who lived about the year of Christ 880. He greatly reformed astronomy, by comparing his own observations with those of Ptolemy. Thus he calculated the motion of the sun's apogee from Ptolemy's time to his own; determined the precession of he equinoxes to be one degree in 70 years; and fixed the sun's greatest declination at 23.35′. Finding that the tables of Ptolemy required much correction, he composed new ones of his own fitted to the meridian of Aracta, which were long held in estimation by the Arabians. After his time, though several eminent astronomers appeared among the Saracens, none made any very valuable observations for several centuries, excepting Ebn Younis astronomer to the caliph of Egypt; who observed three eclipses with such care, that by means of them we are enabled to determine the quantity of the moon's acceleration since that time.

Other eminent Saracen astronomers were, Arzachel a Moor of Spain, who observed the obliquity of the ecliptic, and constructed tables of sines, or half chords of double arcs, dividing the diameter into 300 parts; and Alhazen, his cotemporary, who first showed the importance of the theory of refractions in astronomy; writing also upon the twilight, the height of the clouds, and the phenomenon of the horizontal moon.

Ulug Beg, a grandson of the famous Tartar prince Timur Beg, or Tamerlane, was a great proficient in practical astronomy. He is said to have had very large instruments for making his observations; particularly a quadrant as high as the church of Sancta Sophia at Constantinople, which is 180 Roman feet. He composed astronomical tables from his own observations for the meridian of Samarcand his capital, so exact as to differ very little from those afterwards constructed by Tycho Brahe; but his principal work is his catalogue of the fixed stars, made from his own observations in the year of Christ 1437. The accuracy of his observations may be gathered from his determining the height of the pole at Samarcand to be 39° 37′ 23″.

Besides these improvements, we are indebted to the Arabians for the present form of trigonometry. Manelaus, indeed, an eminent Greek astronomer who flourished about the year 90, had published three books of Spherics, in which he treated of the geometry necessary to astronomy, and which show great skill in the sciences; but his methods were very laborious, even after they had been improved and rendered more simple by Ptolemy: but Geber the Arabian, instead of the ancient method, proposed three or four theorems, which are the foundation of our modern trigonometry. The Arabians also made the practice still more simple, by using sines instead of the chords of double arcs. The arithmetical characters they had from the Indians.

18 Revival of astronomy in Europe.

During the greatest part of this time, almost all Europe continued ignorant not only of astronomy but of every other science. The emperor Frederick II. first began to encourage learning in 1230; restoring some universities, and founding a new one in Vienna. He also caused the works of Aristotle, and the Almagest or Astronomical Treatise of Ptolemy, to be translated into Latin; and from the translation of this book we may date the revival of astronomy in Europe. Two years after its publication, John de Sacro Bosco, or of Halifax, an Englishman, wrote his four books *De Sphæra*, which he compiled from Ptolemy Albategnius, Alferganus, and other Arabian astronomers: this work was so much celebrated, that for 300 years it was preferred in the schools to every other; and has been thought worthy of several commentaries, particularly by Clavius in 1531. In 1240, Alphonso king of Castile caused the tables of Ptolemy to be corrected: for which purpose he assembled many persons skilled in astronomy, Christians, Jews, and Moors; by whom the tables called *Alphonsine* were composed, at the expence of 40,000, or according to others 400,000 ducats. About the same time Roger Bacon, an English monk, published many things relative to astronomy; particularly of the places of the fixed stars, solar rays, and lunar aspects. Vitellio, a Polander, wrote a treatise on Optics about 1270, in which he showed the use of refractions in astronomy.

19 Improvements of Purbach.

From this time to that of Purbach, who was born in 1423, few or no improvements were made in astronomy. He wrote a commentary on Ptolemy's Almagest, some treatises on Arithmetic and Dialling, with tables for various climates. He not only used spheres and globes, but constructed them himself; and formed new tables of the fixed stars, reduced to the middle of that age. He composed also new tables of sines for every ten minutes, which Regiomontanus afterwards extended to every single minute, making the whole sine 60, with 6 ciphers annexed. He likewise corrected the tables of the planets, making new equations to them, because the Alphonsine tables were very faulty in this respect. In his solar tables he placed the sun's apogee in the beginning of Cancer; but retained the obliquity of the ecliptic 23° 33½′, to which it had been reduced by the latest observations. He made new tables for computing eclipses, of which he observed some, and had just published a theory of the planets, when he died in 1461.

20 Of Regiomontanus.

John Muller of Monteregio (Koningsberg), a town of Franconia, from whence he was called *Regiomontanus*,

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nus, was the ſcholar and ſucceſſor of Purbach. He completed the epitome of Ptolemy's Almageſt which Purbach had begun; and after the death of the latter, went to Rome, where he made many aſtronomical obſervations. Having returned to Nuremberg in 1471, he was entertained by a wealthy citizen named *Bernard Walther*, who having a great love for aſtronomy, cauſed ſeveral inſtruments to be made under the direction of Regiomontanus, for obſerving the altitude of the ſun and ſtars, and other celeſtial phenomena. Among theſe was an armillary aſtrolabe, like that which had been uſed by Hipparchus and Ptolemy at Alexandria, and with which many obſervations were made. He alſo made ephemerides for 30 years to come, ſhowing the lunations, eclipſes, &c. He wrote the Theory of the Planets and Comets, and a Treatiſe of Triangles yet in repute for ſeveral extraordinary caſes. He is ſaid to have been the firſt who introduced the uſe of tangents into trigonometry; and to have publiſhed in print (the art of printing having been lately invented) the works of many of the moſt celebrated ancient aſtronomers. After his death, which happened at Rome, Walther made a diligent ſearch for all his inſtruments and papers which could be found; and continued his obſervations with the inſtruments he had till his death. The obſervations of both were collected by order of the ſenate of Nuremberg, and publiſhed there by John Schoner in 1544; afterwards by Snellius at the end of the Obſervations made by the Landgrave of Heſſe in 1618; and laſtly, in 1666, with thoſe of Tycho Brahe. Walther, however, as we are told by Snellius, found fault with his armilla, not being able to give any obſervation with certainty to leſs than ten minutes. He made uſe of a good clock, which alſo was a late invention in thoſe days.

21 Of Werner.

John Werner, a clergyman, ſucceeded Walther as aſtronomer at Nuremberg; having applied himſelf with great aſſiduity to the ſtudy of that ſcience from his infancy. He obſerved the motion of the comet in 1500; and publiſhed ſeveral tracts, in which he handled many capital points of geometry, aſtronomy, and geography, in a maſterly manner. He publiſhed a tranſlation of Ptolemy's Geography, with a commentary, which is ſtill extant. In this he firſt propoſed the method of finding the longitude at ſea by obſerving the moon's diſtance from the fixed ſtars; which is now ſo ſucceſsfully put in practice. He alſo publiſhed many other treatiſes on mathematics and geography; but the moſt remarkable of all his treatiſes, are thoſe concerning the motion of the eighth ſphere or of the fixed ſtars, and a ſhort theory of the ſame. In this he ſhowed, by comparing his own obſervations of the ſtars Regulus, Spica Virginis, and the bright ſtar in the ſouthern ſcale of the Balance, made in 1514, with the places aſſigned to the ſame ſtars by Ptolemy, Alphonſus, and others, that the motion of the fixed ſtars, now called *the preceſſion of the equinoctial points*, is one degree ten minutes in 100 years, and not one degree only, as former aſtronomers had made it. He made the obliquity of the ecliptic 23° 28′, and the firſt ſtar of Aries 26° diſtant from the equinoctial point. He alſo conſtructed a planetarium repreſenting the celeſtial motions according to the Ptolemaic hypotheſis, and made a great number of meteorological obſervations with a view towards the prediction of the weather. The obliquity of the ecliptic was ſettled by Dominic Maria, the friend of Copernicus, at 23° 29′, which is ſtill held to be juſt.

22 Pythagorean ſyſtem reſtored by Copernicus.

The celebrated Nicholaus Copernicus next makes his appearance, and is undoubtedly the great reformer of the aſtronomical ſcience. He was originally bred to the practice of medicine, and had obtained the degree of doctor in that faculty: but having conceived a great regard for the mathematical ſciences, eſpecially aſtronomy, he travelled into Italy, where he for ſome time was taught by Dominic Maria, or rather aſſiſted him in his aſtronomical operations. On his return to his own country, being made one of the canons of the church, he applied himſelf with the utmoſt aſſiduity to the contemplation of the heavens, and to the ſtudy of the celeſtial motions. He ſoon perceived the deficiency of all the hypotheſes by which it had been attempted to account for theſe motions; and for this reaſon he ſet himſelf to ſtudy the works of the ancients, with all of whom he alſo was diſſatisfied excepting Pythagoras; who, as has been already related, placed the ſun in the centre, and ſuppoſed all the planets, with the earth itſelf, to revolve round him. He informs us, that he began to entertain theſe notions about the year 1507; but not being ſatisfied with ſtating the general nature of his hypotheſis, he became deſirous of determining the ſeveral periodical revolutions of the planets, and thence of conſtructing tables of their motions which might be more agreeable to truth than thoſe of Ptolemy and Alphonſus. The obſervations he was enabled to make, however, muſt have been extremely inaccurate; as he tells us, that if with the inſtruments he made uſe of he ſhould be able to come within ten minutes of the truth, he would rejoice no leſs than Pythagoras did when he diſcovered the proportion of the hypothenuſe to the other two ſides of a right-angled triangle. His work was completed in the year 1530; but he could not be prevailed upon to publiſh it till towards the end of his life, partly through diffidence, and partly through fear of the offence which might be taken at the ſingularity of the doctrines ſet forth in it. At laſt, overcome by the importunities of his friends, he ſuffered it to be publiſhed at their expence, and under the inſpection of Schoner and Oſiander, with a dedication to Pope Paul III. and a preface, in which it was attempted to palliate as much as poſſible the extraordinary innovations it contained. During the time of its publication, the author himſelf was attacked by a bloody flux, ſucceeded by a palſy; ſo that he received a copy only a few hours before his death, which happened on the 23d of May 1543.

After the death of Copernicus, the aſtronomical ſcience was greatly improved by Schoner, Nonius, Appian, and Gemma Friſius. Schoner ſurvived Copernicus only four years; however, he greatly improved the methods of making celeſtial obſervations, reformed and explained the calendar, and publiſhed a treatiſe of coſmography. Nonius had applied himſelf very early to the ſtudy of aſtronomy and navigation; but finding the inſtruments at that time in uſe exceſſively inaccurate, he applied himſelf to the invention of others which ſhould be leſs liable to inconvenience. Thus he invented the aſtronomical quadrant, in which he divided the degrees into minutes by a number of concentric

circles.

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23 Several illustrious persons apply to the study of astronomy.

During this century, the list of astronomers was dignified by some very illustrious names. About the year 1561, William IV. landgrave of Hesse Cassel, applied himself to the study of astronomy. With the assistance of Rothman and Burgius, the former an astronomer, the latter an excellent mathematical instrument maker, he erected an observatory on the top of his palace at Cassel, and furnished it with such instruments as were then in use, made in the best manner the artists of that age could execute. With these he made a great number of observations, which were by Hevelius preferred to those of Tycho Brahe, and which were published by Snellius in 1618. From these observations he determined the longitudes and latitudes of 400 stars, which he inserted in a catalogue where their places are rectified to the beginning of the year 1593.

24 Observations of Tycho Brahe.

Tycho Brahe began his observations about the same time with the landgrave of Hesse, already mentioned. He observed the great conjunction of Saturn and Jupiter in 1563; and finding the instruments he could procure very inaccurate, he made a quadrant capable of showing single minutes, and likewise a sextant four cubits radius. In 1571, he discovered a new star in the chair of Cassiopeia; which induced him, like Hipparchus, to make a catalogue of the stars. This contained the places of 777 stars, rectified to the year 1600; but instead of the moon, which was used by the ancients to connect the places of the sun and stars, Tycho substituted Venus, as having little or no parallax, and yet being like the moon visible both day and night. By the recommendation of the landgrave of Hesse, he obtained from the king of Denmark the island of Huenna, opposite to Copenhagen, where an observatory was built. The first stone of this building, afterwards called *Uraniburg*, was laid in the year 1576. It was of a square form, one side of it being about 60 feet in length; and on the east and west sides were two round towers of 32 feet diameter each. The instruments were larger and more solid than had ever been seen before by any astronomer. They consisted of quadrants, sextants, circles, semicircles, armillæ both equatorial and zodiacal, parallactic rulers, rings, astrolabes, globes, clocks, and sun-dials. These instruments were so divided as to show single minutes; and in some the arch might be read off to 10 seconds. Most of the divisions were diagonal: but he had one quadrant divided according to the method invented by Nonius; that is, by 47 concentric circles. The whole expence is said to have amounted to 200,000 crowns. The method of dividing by diagonals, which Tycho greatly admired, was the invention of Mr Richard Chanceler, an Englishman: Tycho, however, shows, that it is not accurately true when straight lines are employed, and the circles at equal distances from each other; but that it may be corrected by making circular diagonals, which if continued would pass through the centre. History. 25 Account of Uraniburg, his observatory.

Tycho employed his time at Uraniburg to the best advantage; but falling into discredit on the death of the king, he was obliged to remove to Holstein, and at last found means to get himself introduced to the emperor, with whom he continued to his death. He is well known to have been the inventor of a system of astronomy, which bears his name; and which he vainly endeavoured to establish on the ruins of that of Copernicus: but the simplicity and evident consonancy to the phenomena of nature, displayed in all parts of the Copernican system, soon got the better of the unnatural and complicated system of Tycho. His works, however, which are very numerous, discover him to have been a man of vast abilities. After his death the castle of Uraniburg quickly fell to decay, and indeed seems to have been purposely pulled down; for, in 1652, when Mr Huet went to Sweden, it was almost level with the ground, and few traces of the walls could be discerned. None of the neighbouring inhabitants had ever heard of the name of Tycho or Uraniburg, excepting one old man, whom Mr Huet found out with great difficulty, and who had been a servant in the family! All the discoveries of Purback, Regiomontanus, and Tycho, were collected and published in the year 1621, by Longomontanus, who had been Tycho's favourite scholar.

While Tycho resided at Prague with the emperor, he invited thither John Kepler, afterwards so famous for his discoveries. Under the tuition of so great an astronomer, the latter quickly made an amazing progress. 26 Discoveries of Kepler.

History. progress. He found that his predecessors had erred in supposing the orbits of the planets to be circular, and their motions uniform: on the contrary, he perceived, from his own observations, that they were elliptical, and their motions unequal, having the sun in one of the foci of their orbits; but that, however they varied in absolute velocity, a line drawn from the centre of the sun to the planet, and revolving with it, would always describe equal areas in equal times. He discovered, in the year 1618, that the squares of the periodical times are as the cubes of the distances of the planets; two laws which have been of the greatest importance to the advancement of astronomy. He seems to have had some notion of the extensive power of the principle of gravity: for he tells us, that gravity is a mutual power betwixt two bodies; that the moon and earth tend towards each other, and would meet in a point nearer the earth than the moon in the proportion of the superior magnitude of the former, were they not hindered by their projectile motions. He adds also, that the tides arise from the gravitation of the waters towards the moon: however, he did not adhere steadily to these principles, but afterwards substituted others as the causes of the planetary motions.

Cotemporary with Kepler were Mr Edward Wright, and Napier, baron of Merchiston. To the former we owe several very good meridional observations of the sun's altitude, made with a quadrant of six feet radius, in the years 1594, 1595, and 1596; from which he greatly improved the theory of the sun's motion, and computed more exact tables of his declination than had been done by any person before. He published also, in 1599, an excellent treatise, entitled, "Certain Errors in Navigation discovered and detected." To the latter we are indebted for the knowledge of logarithms; a discovery, as was justly observed by Dr Halley, one of the most useful ever made in the art of numbering. John Bayer, a German, who lived about the same time, will ever be memorable for his work, entitled, *Uranometria*, which is a very complete celestial atlas, or a collection of all the constellations visible in Europe. To this he added a nomenclature, in which the stars in each constellation are marked with the letters of the Greek alphabet; and thus every star in the heavens may be referred to with the utmost precision and exactness. About the same time also, astronomy was cultivated by many other persons; abroad, by Maginus, Mercator, Maurolycus, Homelius, Schultet, Stevin, &c.; and by Thomas and Leonard Digges, John Dee, and Robert Flood, in England: but none of them made any considerable improvement.

27 Invention of telescopes, and consequent discoveries.

The beginning of the 17th century was distinguished not only by the discovery of logarithms, but by that of telescopes; a sort of instruments by which astronomy was brought to a degree of perfection utterly inconceivable by those who knew nothing of them. The question concerning the inventor is discussed under the article OPTICS; but whoever was entitled to this merit, it is certain that Galileo was the first who brought them to such perfection as to make any considerable discoveries in the celestial regions. With instruments of his own making, Galileo discovered the inequalities in the moon's surface, the satellites of Jupiter, and the ring of Saturn; though this last was unknown to him after he had seen it, and the view he got made him conclude that the planet had a threefold body, or that it was of an oblong shape like an olive. He discovered spots on the sun, by means of which he found out the revolution of that luminary on his axis; and he discovered also that the milky way and nebulæ were full of small stars. It was not, however, till some time after these discoveries were made, that Galileo and others thought of applying the observations on Jupiter's satellites to the purpose of finding the longitude of places on the surface of the earth; and even after this was thought of, astronomers found it so difficult to construct tables of their motions, that it was not till after many observations had been made in distant places of the world, that Cassini was able to determine what positions of the satellites were most proper for finding out the longitude. At last he perceived that the entrance of the first satellite into the shadow of Jupiter, and the exit of it from the same, were the most proper for this purpose: that next to these the conjunctions of the satellites with Jupiter, or with one another, may be made use of; especially when any two of them, moving in contrary directions, meet with each other: and lastly, that observations on the shadows of the satellites, which may be seen on the disk of Jupiter, are useful, as also the spots which are seen upon his face, and are carried along it with greater velocity than has hitherto been discovered in any of the other heavenly bodies.

28 Logarithmic tables composed.

While astronomers were thus busy in making new discoveries, the mathematicians in different countries were no less earnestly employed in constructing logarithmic tables to facilitate their calculations. Benjamin Ursinus, an excellent mathematician of Brandenburg, calculated much larger tables of logarithms than had been done by their noble inventor, and published them in 1625. They were improved by Henry Briggs, Savilian professor of Oxford; who by making unity the logarithm of ten, thus rendered them much more convenient for the purposes of calculation. Logarithmic tables of sines and tangents were also composed by Mr Briggs and Adrian Vlacq at Goude, so that the business of calculation was now rendered nearly as easy as possible.

29 Transit of Venus first observed by Mr Horrox.

In 1633, Mr Horrox, a young astronomer of very extraordinary talents, discovered that Venus would pass over the disk of the sun on the 24th of November 1639. This event he announced only to one friend, a Mr Crabtree; and these two were the only persons in the world who observed this transit the first time it had ever been viewed by human eyes. Mr Horrox made many useful observations at the time; and had even formed a new theory of the moon, so ingenious as to attract the notice of Sir Isaac Newton; but the hopes of astronomers from the abilities of this excellent young man were blasted by his death in the beginning of January 1640.

30 Foundation of the Academy of Sciences at Paris and Royal Society at London.

About the year 1638 many learned men began to assemble at Paris in order to hold conferences on different scientific subjects, which was the first foundation of the Royal Academy of Sciences in that capital. This practice was introduced in France by Mersennus, and soon after at London by Oldenburg; which laid the foundation of the Royal Society there. About this time also the celebrated astronomer Hevelins flourished at Dantzic, building an observatory in his own house,

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house, and furnishing it with excellent instruments of his own construction; particularly octants and sextants of brass of three and four feet radius, as well as telescopes, with which he constantly observed the spots and phases of the moon, and from which observations he afterwards compiled his excellent and beautiful work entitled *Selenographia*. This noble building, together with all the books and instruments it contained, was consumed by fire on the 26th of September 1679; but the memory, as well as the form and construction of the instruments, is preserved in a curious work of the ingenious inventor, entitled *Machina Cælestis*; though almost the whole impression of this book was involved in the same fate with the instruments it describes. The damage sustained on this occasion was estimated at 30,000 crowns.

The celebrated English mechanic Dr Hooke, who was cotemporary with Hevelius, had in the mean time invented instruments with telescopic sights, which he preferred to those used by Hevelius so much, that a dispute commenced, which procured Hevelius a visit from Dr Halley. The latter had at that time taken a voyage to St Helena, at the desire of the Royal Society, in order to observe and form a catalogue of the stars in the southern hemisphere. The result of his observations with Hevelius's instruments was, that three several observations on the Spica Virginis and Regulus differed only a few seconds from each other. They were the invention of Tycho Brahe, and are described under the article OPTICS. At this visit Halley and Hevelius observed an occultation of Jupiter by the moon, and determined the diameter of the latter to be 30′, 33″.

In 1671 the royal observatory in Paris was finished, and the use of it assigned to Mr Cassini, after it had been furnished with instruments at a very great expence: and the observatory at Greenwich being likewise built five years after, Mr Flamstead was appointed astronomer-royal. The observations in both these places, however, have been so numerous, that it is in vain to attempt any account of them.

31 Improvements in telescopes.

Before the middle of the 17th century the construction of telescopes had been greatly improved, particularly by Fontana and Huygens. The latter constructed one of 123 feet, which is still preserved in the museum of the Royal Society at London. With this he observed the moon and planets for a long time, and discovered that Saturn was encompassed with a ring. The French, however, still outdid the English artists; and by means of telescopes of 200 and 300 feet focus, Mr Cassini was enabled to see all the five satellites of Saturn, his belts, and the shadows of Jupiter's satellites passing over his body. In 1666 Mr Azout applied a micrometer to telescopes for the purpose of measuring the diameters of the planets, and small distances in the heavens; however, an instrument of this kind had been before invented by Mr Gascoigne, though it was but little known abroad.

Notwithstanding all these discoveries by means of telescopes, it was evident that they still continued in a very imperfect state, and their imperfections at the time appeared to be without remedy. One defect was the enormous length requisite to admit of any very considerable magnifying power; and another was the incorrectness of the image arising from the aberration of the rays, as was then supposed, by the spherical figure of the glass. To obviate these inconveniences, Mersennus is said to have first proposed, in a letter to Descartes, the use of reflectors instead of lenses in the construction of telescopes; but this he did in such an obscure manner, that the latter laboured to persuade him of the falsehood of the principle on which his scheme was founded. In 1663, however, James Gregory of Aberdeen showed how such a telescope might be constructed. He showed also, that, in order to form a perfect image of an object in this manner, the figure of the speculum ought to be parabolic; but Sir Isaac Newton, who applied himself to the framing of telescopes of the reflecting kind, found it impracticable to grind them of the desired figure. Laying aside the idea of reflecting telescopes, therefore, he applied himself to the execution of a scheme formed by Descartes, viz. that of grinding lenses of the figure of one of the conic sections. In prosecuting this plan, he discovered, that the greatest errors to which telescopes were subject arose from the different refrangibility of the rays of light, for which he could not then find any remedy. He therefore returned to the scheme he had just abandoned; and, in the year 1672, presented to the Royal Society two reflectors which were constructed with spherical speculums, as he could not procure any other. The inconveniences arising from the different refrangibility of the rays of light, have since been in the fullest manner corrected by Mr Dollond, the excellency of whose achromatic telescopes is too well known to need any encomium.

About the beginning of the present century, the practical part of astronomy seemed to languish for want of proper instruments. Roemer, indeed, had invented some new ones, and Dr Hooke had turned his attention towards this subject in a very particular manner; but either through want of skill in the artists, or some other unfortunate circumstance, it happened that nothing effectual was done. But at the very time when this was the case with practical astronomy, the speculative part was carried in a manner to its utmost pitch by the labours of the immortal Newton, whose Principia gave an entire new face to the science. It was not, however, for many years relished by the foreign philosophers, though almost immediately adopted at home, and has continued ever since to spread its reputation farther and farther, so that now it is in a manner established all over the world. "But (says Dr Long) that, after Newton's system had for so long a time been neglected, it should all at once be universally received and approved of, is not to be attributed to chance, or the caprice of fashion, as some who are ignorant of it are apt to think, and from thence to expect that some other system will hereafter take its place, and bury it in oblivion. The system of Newton, like that of Copernicus, is so agreeable to the phenomena of nature, and so well put together, that it *must* last as long as truth and reason endure, although time may perhaps bring the word attraction into disuse; and though it may no longer be thought inherent in matter, yet the laws of gravitation, as they are now called, and on which this system is founded, will never be forgotten."

It was also in Britain that the first improvements in astronomical instruments took place. The celebrated

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mechanic and watchmaker, Graham, carried the accuracy of his instruments to a degree which surprised every one. He also greatly improved the principles of watch-work, and made clocks to go with much greater regularity than before. The old eight feet mural arch at Greenwich was also constructed by him; as was a small equatorial sector for making observations out of the meridian; but he is chiefly remarkable for contriving the zenith sector of 24 feet radius, and afterwards one of 12½ feet, by which Dr Bradley discovered the aberration of the fixed stars. The reflecting telescope which had been invented by Gregory, and executed by Newton, was greatly improved by Mr Hadley, and a very complete and powerful instrument of that kind was presented to the Royal Society in 1719. The same gentleman has also immortalized his memory by the invention of the reflecting quadrant, which he presented to the Society in 1731, which is now in universal use at sea; and without which all improvements of the lunar theory would have been useless for determining the longitude, through the want of an instrument proper to make the observations with. It however appears, that an instrument, exactly similar to this in its principles, had been invented by Sir Isaac Newton, and a description of it, together with a drawing, given by the inventor to Dr Halley, when he was preparing for his voyage to discover the variation of the needle in 1701. About the middle of this century, the constructing and dividing of large astronomical instruments was carried to a great degree of perfection by Mr John Bird; reflecting telescopes were equally improved by Mr Short, who first executed the divided object-glass micrometer. This had indeed been thought of by M. Louville, and several other persons long before; and a description of one nearly agreeing with that of Mr Short had been published in the Philosophical Transactions for 1753: but had it not been for the great skill of Mr Short in figuring and centering glasses of this kind, it is very probable the scheme might never have been executed. About this time also Mr Dollond brought refracting telescopes to such perfection, that they became superior to reflectors of equal length; though all of them are now excelled by those of Mr Herschel, whose telescopic discoveries have been far more numerous and surprising than those of any other astronomer.

32 Astronomical instruments first improved in England.

33 Improvements within this last century.

We shall close this history with a short account of the labours of the principal astronomers since the building the royal observatories at Paris and Greenwich, and the appointment of Mr Flamstead to the office of astronomer royal. This gentleman not only made observations on the sun, moon, planets, and comets which appeared in his time, but on the fixed stars also, of which he gave a catalogue of 3000; many of them so small that they cannot be discerned without the help of a telescope: he also published new solar tables, and a theory of the moon according to Horrox. He published a very curious tract on the doctrine of the sphere, in which he showed how to construct eclipses of the sun and moon, as well as occultations of the fixed stars by the moon, geometrically; and it was upon his observations that Halley's tables and Newton's theory of the moon were constructed. Mr Cassini also distinguished himself very considerably. He erected the gnomon, and drew the famous meridian line in the church of Petronia at Bologna. He enjoyed his office more than 40 years, making many observations on the sun, moon, planets, and comets, and greatly amended the elements of their motions; though the result of his labours was much inferior to Mr Flamstead's. The office was continued in his family, and his grandson still enjoys it. Rœmer, a celebrated Danish astronomer, first discovered the progressive motion of light by observing the eclipses of Jupiter, and read a dissertation upon it before the Royal Academy of Sciences at Paris in the year 1675. He was also the first who made use of a meridional telescope.

Mr Flamstead was succeeded in 1719 by Dr Halley, "the greatest astronomer (says M. de la Lande) without contradiction in England;" and, adds Dr Long, "I believe he might have said in the whole world." He had been sent, at the age of 21, by King Charles II. to the island of St Helena, in order to make a catalogue of the southern stars, which was published in 1679. In 1705, he published his *Synopsis Astronomiæ Cometicæ*, in which, after immense calculation, he ventured to predict the return of one in 1758 or 1759. He also published many learned dissertations in the Philosophical Transactions concerning the use that might be made of the next transit of Venus in determining the distance of the sun from the earth. He was the first who discovered the acceleration of the moon, and gave a very ingenious method of finding her parallax by three observed phases of a solar eclipse. He composed tables of the sun, moon, and all the planets; and, in the nine years in which he was at Greenwich, made near 1500 observations of the moon; all which he compared with the tables, and noted the differences; and these, he thought, would return in about 18 years. He recommended the method of determining the longitude by means of the moon's distance from the sun and certain fixed stars. He was convinced of its superior excellence; and is has since been adopted by all the most eminent astronomers in Europe. It is at present the only sure guide to the mariner; and the great perfection to which it is now brought is much owing to the industry and exertions of Dr Maskelyne, the present astronomer-royal, to whom we are indebted for the publication of the Nautical Almanack, the Requisite Tables, and other works of the utmost service to practical astronomy.

In the mean time an attempt was made in France to measure a degree of the earth, which occasioned a very warm dispute concerning the figure of it. Cassini, from Picart's measure, concluded that the earth was an oblong spheroid; but Newton, from a consideration of the laws of gravity and the diurnal motion of the earth, had determined the figure of it to be an oblate spheroid, and flatted at the poles. To determine this point, Louis XV. resolved to have two degrees of the meridian measured; one under, or very near the equator; and the other as near the pole as possible. For this purpose the Royal Academy of Sciences sent M. Maupertuis, Clairault, Camus, and Le Monier, to Lapland. They were accompanied by the Abbé Outhier, a correspondent of the same academy. They were joined by M. Celsius professor of anatomy at Upsal; and having set out from France in the spring of the year 1736, returned to it in 1737, after having fully

34 True figure of the earth discovered.

History. fully accompliſhed their errand. On the ſouthern expedition were deſpatched M. Godin, Condamine, and Bouguer, to whom the king of Spain joined Don George Juan and Don Anthony de Ulloa, two very ingenious gentlemen and officers of the marine. They left Europe in 1735; and after enduring innumerable hardſhips and difficulties in the execution of their commiſſion, returned to Europe at different times, and by different ways, in the years 1744, 1745, and 1746. The reſult of this arduous taſk was a confirmation of Newton's inveſtigation. Picart's meaſure was reviſed by Caſſini and De la Caille; and, after his errors were corrected, it was found to agree very well with the other two. On this occaſion too it was diſcovered, that the attraction of the great mountains of Peru had an effect on the plumb-line of one of their largeſt inſtruments, drawing it ſeven or eight ſeconds from the true perpendicular.

Dr Halley, dying in 1742, was ſucceeded by Dr Bradley, who, though inferior as a mathematician, greatly exceeded him as a practical aſtronomer. He was the firſt who made obſervations with an accuracy ſufficient to detect the leſſer inequalities in the motions of the planets and fixed ſtars. Thus he diſcovered the aberration of light, the nutation of the earth's axis, and was able to make the lunar tables much more perfect than they had ever been. He alſo obſerved the places, and computed the elements of the comets which appeared in the years 1723, 1736, 1743, and 1757. He made new and moſt accurate tables of the motions of Jupiter's ſatellites, from his own obſervations and thoſe of Dr Pound; and from a multitude of obſervations of the ſun, moon, and ſtars, was enabled to give the moſt accurate table of mean refractions yet extant, as well as the beſt methods of computing the variations of thoſe refractions ariſing from the different ſtates of the air as indicated by the thermometer and barometer. In 1750, having procured a very large tranſit inſtrument made by Mr Bird, and a new mural quadrant of braſs eight feet radius, he began to make obſervations with redoubled induſtry; ſo that betwixt this time and his death, which happened in 1762, he made obſervations for ſettling the places of all the ſtars in the Britiſh catalogue, together with near 1500 places of the moon, much the greater part of which he compared with the tables of Mr Mayer.

35 Improvements by the French aſtronomers.

In the mean time the French aſtronomers were aſſiduous in their endeavours to promote the ſcience of aſtronomy. The theory of the moon, which had been given in a general way by Sir Iſaac Newton, began to be particularly conſidered by Meſſrs Clairault, D'Alembert, Euler, Mayer, Simpſon, and Walmſly; though Clairault, Euler, and Mayer, diſtinguiſhed themſelves beyond any of the reſt, and Mr Euler has been particularly happy in the arrangement of his tables for the eaſe and expedition of computation. He was excelled in exactneſs, however, by Mayer, who publiſhed his tables in the Gottingen Acts for 1753. In theſe the errors in longitude never exceeded two minutes; and having yet farther improved them, he ſent a copy to the lords of the Britiſh admiralty in 1755; and it was this copy which Dr Bradley compared with his obſervations, as already mentioned. His laſt corrections of them were afterwards ſent over by his widow; for which ſhe and her children received a reward of 3000l. Accurate tables for Jupiter's ſatellites were alſo compoſed by Mr Wargentin a moſt excellent Swediſh aſtronomer, and publiſhed in the Upſal Acts in 1741; which have ſince been corrected by the author in ſuch a manner as to render them greatly ſuperior to any ever publiſhed before.

36 Of M. de la Caille.

Amongſt the many French aſtronomers who contributed to the advancement of the ſcience, we are particularly indebted to M. de la Caille, for a moſt excellent ſet of ſolar tables, in which he has made allowances for the attractions of Jupiter, Venus, and the moon. In 1750 he went to the Cape of Good Hope, in order to make obſervations in concert with the moſt celebrated aſtronomers in Europe, for determining the parallax of the moon, as well as of the planet Mars, and from thence that of the ſun; from whence it appeared that the parallax of the ſun could not greatly exceed 10 ſeconds. Here he re-examined and adjuſted the places of the ſouthern ſtars with great accuracy, and meaſured a degree of the meridian at that place. In Italy the ſcience was cultivated with the greateſt aſſiduity by Signior Bianchini, Father Boſcovich, Friſi, Manfredi, Zanotti, and many others; in Sweden by Wargentin already mentioned, Blingenſtern, Mallet, and Planman; and in Germany, by Euler elder and younger, Mayer, Lambert, Griſchow, &c. In the year 1760 all the learned ſocieties in Europe began to prepare for obſerving the tranſit of Venus over the ſun, foretold by Dr Halley upwards of 80 years before it happened, ſhowing, at the ſame time, the important uſe which might be made of it. Unfortunately, however, for the cauſe of ſcience, many of the aſtronomers ſent out to obſerve this phenomenon were prevented by unavoidable accidents from reaching the places of their deſtination, and others were diſappointed by the badneſs of the weather. It happened alſo, that the circumſtances of the phenomenon were much leſs favourable for the purpoſe of determining the ſun's parallax than had been expected by Dr Halley, owing to the faults of the tables he made uſe of: ſo that, notwithſtanding all the labours of aſtronomers at that time, they were not able to determine the matter: and even after their obſervations in 1769, when the circumſtances of the tranſit were more favourable, the parallax of the ſun remained ſtill uncertain.

Dr Bradley was ſucceeded in his office of aſtronomer-royal by Mr Bliſs Savilian profeſſor of aſtronomy at Oxford; who, being in a very declining ſtate of health at the time of his acceſſion to the office, did not enjoy it long. He was ſucceeded by the learned Nevil Maſkelyne, D. D. the preſent aſtronomer-royal, whoſe name will be rendered immortal by his aſſiduity and ſucceſs in bringing the lunar method of determining the longitude at the ſea into general practice.

Such was the general ſtate of aſtronomy, when Dr Herſchel's great diſcovery of augmenting the power of teleſcopes, beyond the moſt ſanguine hopes of aſtronomers, opened at once a ſcene altogether unlooked for. By this indefatigable obſerver we are made acquainted with a new primary planet attended by ſix ſecondaries belonging to our ſolar ſyſtem; ſo that the latter now appears to have double the bounds formerly aſſigned to it; this new planet being at leaſt twice the diſtance of Saturn from the ſun. In the ſtill farther diſtant celeſtial regions, among the fixed ſtars, his obſervations

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vations are equally ſurpriſing; of which we ſhall only ſay with Dr Prieſtley*, "Mr Herſchel's late diſcoveries in and beyond the bounds of the ſolar ſyſtem, the great views that he has given of the arrangement of the ſtars, their revolutions, and thoſe of the immenſe ſyſtems into which they are formed, are peculiarly calculated to inſpire an ardent deſire of ſeeing ſo great a ſcene a little more unfolded. Such diſcoveries as theſe give us a higher idea of the value of our being, by raiſing our ideas of the ſyſtem of which we are a part; and with this an earneſt wiſh for the continuance of it."

* *Exper. and Obſerv.* vol. VI. Pref.

Part II. OF THE APPARENT MOTIONS OF THE HEAVENLY BODIES.

37 Appearance of the heavens.

When we caſt our eyes up towards the heavens, we perceive a vaſt hollow hemiſphere at an unknown diſtance, of which our eye ſeems to conſtitute the centre. The earth ſtretches at our feet like an immenſe plain, and at a certain diſtance appears to meet and to bound the heavenly hemiſphere. Now the circle all around, where the earth and the heavens ſeem to meet and touch each other, is called the *horizon.* We can ſcarcely avoid ſuppoſing, that beſides the hemiſphere which we perceive, there is another, exactly ſimilar, concealed from our view by the earth, and that the earth, therefore, is ſomehow or other ſuſpended in the middle of this heavenly ſphere, with all its inhabitants. A little obſervations turns this ſuſpicion into certainty. For in a clear evening the heavenly hemiſphere is ſeen ſtudded with ſtars, and its appearance is changing every inſtant. New ſtars are continually riſing in the eaſt, while others in the mean time are ſetting in the weſt. Thoſe ſtars, that, towards the beginning of the evening, were juſt ſeen above the eaſtern horizon, late at night are ſeen in the middle of the ſtarry hemiſphere, and may be traced moving gradually weſtward, till at laſt they ſink altogether under the horizon. If we look to the north, we ſoon perceive, that many ſtars in that quarter never ſet at all, but move round and round, deſcribing a complete circle in 24 hours. Theſe ſtars deſcribe their circles round a fixed point in the heavens; and the circles are the ſmaller, the nearer the ſtar is to the fixed point. This fixed point is called the *north pole.* There muſt be a ſimilar fixed point in the ſouthern hemiſphere, called the *ſouth pole.* Thus the heavenly ſphere appears to turn round two fixed points, called the poles, once every 24 hours. The imaginary line which joins the points is called the *axis* of the world.

In order to have preciſe notions of the motions of the heavenly bodies, it is neceſſary to be able to aſſign preciſely the place in which they are. This is done by means of ſeveral imaginary lines, or rather circles, ſuppoſed deſcribed upon the ſurface of the ſphere; and theſe circles, as is uſual with mathematicians, are divided into 360 equal parts called degrees. Every degree is divided into 60 minutes; every minute into 60 ſeconds, and ſo on. That great circle of the ſphere, which is perpendicular to the axis of the world, and of courſe 90° diſtant from either pole, is called the *equator.* The ſmaller circles, which the ſtars deſcribe in conſequence of their diurnal motions, are called *parallels*, becauſe they are obviouſly parallel to the equator.

The equator divides the heavenly ſphere into two equal parts, the north and the ſouth; but to be able to aſſign the poſition of the ſtars, it is neceſſary to have another circle, paſſing through the poles, and cutting the equator perpendicularly. This circle, is called a *meridian.* It is ſuppoſed, not only to paſs through the poles, but to paſs alſo through the point directly over the head of the obſerver, and the point of the ſphere exactly oppoſite to that. The firſt of theſe points is called the *zenith*, the ſecond is called the *nadir.*

The meridian divides the circles deſcribed by the ſtars into two equal parts; and when they reach it they are either at their greateſt height above the horizon, or they are at their leaſt height. The ſituation of the pole is eaſily determined; for it is preciſely half way between the greateſt and leaſt height of thoſe ſtars which never ſet. When we advance towards the north we perceive that the north pole does not remain ſtationary, but riſes towards the zenith, nearly in proportion to the ſpace we paſs over. On the other hand it ſinks juſt as much when we travel towards the ſouth. Hence we learn that the ſurface of the earth is not plane, as one would at firſt ſuppoſe, but curved.

All the heavenly bodies appear to deſcribe a complete circle round the earth every 24 hours. But beſides theſe motions which are common to them all, there are ſeveral of them which poſſeſs motions peculiar to themſelves. The ſun, the moſt brilliant of all the heavenly bodies, is obviouſly much farther to the ſouth during winter than during ſummer. He does not, therefore, keep the ſame ſtation in the heavens, nor deſcribe the ſame circle every day. The moon not only changes her form, diminiſhes, and increaſes; but if we obſerve the ſtars, near which ſhe is ſituated one evening, the next evening we ſhall find her conſiderably to the eaſtward of them; and every day ſhe removes to a ſtill greater diſtance, till in a month, ſhe makes a complete tour of the heavens, and approaches them from the weſt. There are eight other ſtars, beſides, which are continually changing their place; ſometimes we obſerve them moving to the weſtward, ſometimes to the eaſtward, and ſometimes they appear ſtationary for a conſiderable time. Theſe ſtars are called *planets.* There are other bodies which appear only occaſionally, move for ſome time with immenſe celerity, and afterwards vaniſh. Theſe bodies are called *comets.* But the greater number of the heavenly bodies always retain nearly the ſame relative diſtance from each other, and are therefore called *fixed ſtars.* It will be neceſſary for us to conſider the nature and apparent motions of all theſe bodies. We ſhall, therefore, divide this firſt part of our treatiſe, into the following heads: 38 Arrangement.

1. Of the Sun.
2. Of the Moon.
3. Of the Planets.
4. Of the Comets.
5. Of the Fixed Stars.
6. Of the figure of the Earth.

Theſe topics ſhall be the ſubjects of the following chapters.

Chap.

Chap. I. *Of the Sun.*

The ſun, as the moſt conſpicuous and moſt important of all the heavenly bodies, would naturally claim the firſt place in the attention of aſtronomers. Accordingly its motions were firſt ſtudied, and they have had conſiderable influence on all the other branches of the ſcience. We ſhall ſubdivide this part of our ſubject into three parts. In the firſt, we ſhall give an account of the apparent motions of the ſun; in the ſecond, we ſhall treat of the diviſion of time, which is regulated by theſe apparent motions; and in the third, we ſhall conſider the figure and ſtructure of the ſun, as far as they have been determined by aſtronomers. Theſe ſhall be the ſubjects of the following ſections.

Sect. I. *Apparent Motions of the Sun.*

39 Annual motion of the ſun.

That the ſun has a peculiar motion of its own, independent of the diurnal motion common to all the heavenly bodies, and in a direction contrary to that motion, is eaſily aſcertained, by obſerving with care the changes which take place in the ſtarry hemiſphere during a complete year. If we note the time at which any particular ſtar riſes, we ſhall find that it riſes ſomewhat ſooner every ſucceſſive day, till at laſt we loſe it altogether in the weſt. But if we note it after the interval of a year, we ſhall find it riſing preciſely at the ſame hour as at firſt. Thoſe ſtars which are ſituated nearly in the track of the ſun, and which ſet ſoon after him, in a few evenings loſe themſelves altogether in his rays, and afterwards make their appearance in the eaſt before ſunriſe. The ſun then moves towards them in a direction contrary to his diurnal motion. It was by obſervations of this kind that the ancients aſcertained his orbit. But at preſent this is done with greater preciſion, by obſerving every day the height of the ſun when it reaches the meridian, and the interval of time which elapſes between his paſſing the meridian and that of the ſtars. The firſt of theſe obſervations gives us the ſun's daily motion northward or ſouthward, in the direction of the meridian; and the ſecond gives us his motion eaſtward in the direction of the parallels; and by combining the two together, we obviouſly obtain his orbit: But it will be neceſſary to be ſomewhat more particular.

40 Method of drawing a meridian line.

Theſe obſervations cannot be made without drawing a meridian line, or a line, which, if produced, would paſs through both the poles of the earth, and the ſpot where the obſerver is placed. It is obvious, that ſuch a line is in the ſame plane with the meridian as the the heavenly hemiſphere. A meridian line may be found thus: On an horizontal plane deſcribe three or four concentric circles, as E, G, H, fig. 1. Plate LIX. and in the common centre fix perpendicularly a wire CB, having a well-defined point. When the ſun ſhines in the morning, obſerve where the ſhadow of the top of the wire, as CD, touches one of the circles; and in the afternoon mark where the extremity of the ſhadow CF juſt touches the ſame circle: then through the centre C draw the line CE, biſecting the arc DF, and CE will be a meridian, as required. If the ſame be done with as many of the circles as the ſhining of the ſun will admit of, and the mean of all the biſecting lines CE be choſen as a meridian, there will be no doubt of its accuracy, particularly if the obſervations be made about midſummer, which is the beſt time. After a meridian line is thus found, another parallel to it may be readily drawn at any convenient diſtance: the method is this: Hang a thread and plummet exactly over the ſouth end of the known meridian line, and let another thread and plummet be hung over the ſouth end of the plane upon which a meridian is to be drawn; then let a perſon obſerve when the ſhadow of the thread falls on the given meridian, and immediately give a ſignal to another perſon, who muſt at that moment mark two points on the ſhadow of the ſecond thread, through which two points the new meridian muſt be deſcribed.

41 Altitude of the ſun.

The height of the ſun from the horizon, when it paſſes the meridian, or the arch of the meridian between the ſun and the horizon, is called the *ſun's altitude*. The ancients aſcertained the ſun's altitude in the following manner: They erected an upright pillar at the ſouth end of a meridian line, and when the ſhadow of it exactly coincided with that line, they accurately meaſured the ſhadow's length, and then, knowing the height of the pillar, they found, by an eaſy operation in plane trigonometry, the altitude of the ſun's upper limb: whence, after allowing for the apparent ſemidiameter, the altitude of the ſun's centre was known. But the methods now adopted are much more accurate. In a known latitude, a large aſtronomical quadrant, of ſix, eight, or ten feet radius, is fixed truly upon the meridian; the limb of this quadrant is divided into minutes, and ſmaller ſubdiviſions, by means of a vernier; and it is furniſhed with a teleſcope (having croſs hairs, &c. turning properly upon the centre). By this inſtrument the altitude of the ſun's centre is very carefully meaſured, and the proper deductions made.

42 Method of aſcertaining the ſun's motion.

With a ſimilar inſtrument we may aſcertain the apparent motions of the ſun in the following manner, beginning our obſervations about the 20th of March. On this day we muſt note ſome fixed ſtar which comes to the meridian exactly at the ſame time as the ſun does; for the ſtars may be ſeen in the daytime with an aſtronomical teleſcope. On the following day, both the altitude of the ſun, and the ſituation of the ſtars when the ſun is on the meridian, muſt be obſerved; the ſun's meridian altitude will be about 23′ 40″ greater than on the former day, and the ſtar will be found on the meridian about 3 m. 39 ſec. in time before the ſun. Make ſimilar obſervations for a few days, and it will be found at the end of a week, that the ſun's meridian altitude will be increaſed 2° 46′, and the ſtar will be on the meridian 25 m. 26 ſec. in time before the ſun, or it will be 6° 21½′ weſtward of the meridian when the ſun is upon it. During this period of ſeven days, therefore, the ſun has been moving towards the eaſt, and has increaſed his altitude by regular gradations. In fig. 2. let EQ repreſent a portion of the equator, QS the meridian on which the ſun is, QS his altitude above the equator, E the place of the ſtar, and ES part of the path of the ſun: then, in the ſpherical triangle EQS, right-angled at Q, there are given EQ = 6° 21½′, and QS = 2° 46′, to find the angle E. By the rules of ſpherical trigonometry,

we have, $\text{tangt. of } E = \frac{\text{tangt. of SQ}}{\text{ſine of QE}} = \frac{\cdot 0483250}{\cdot 1107463} = \cdot 4364479$

·4364479 = tangt. of 23° 34′ 43″, the angle E required.

43 Ecliptic. The orbit in which the sun moves is called the *ecliptic*. It does not coincide with the equator, but cuts it, forming with it an angle, which in the year 1769 was determined by Dr Maskelyne, at 23° 28′ 10″, or 23°.46944. This angle is called the *obliquity of the ecliptic*.

44 Seasons explained. The different seasons of the year are occasioned by the combination of this proper motion of the sun with his diurnal motion. The two points in which the ecliptic cuts the equator, are called the *equinoxes*, or *equinoctial points*; because on the days that the sun is in them, he describes by his diurnal motion the equator, which being divided into two equal parts by the horizon, the day is then equal to the night in every part of the earth. One of these equinoxes is called the *vernal*, because the sun is in it about the 20th of March, or the beginning of the spring. As the sun advances in his orbit from that point, his meridian altitude becomes greater and greater every day. The visible arches of the parallels which it describes, become continually greater; and with them the length of the day increases, till the sun reaches his greatest altitude, or distance from the equator: then the day is the longest of the year. And as at that period the variations in the sun's altitude are scarcely sensible for some time, as far at least as it affects the length of the day; the point of the orbit, where the sun's altitude is a maximum, has for that reason been called the *summer solstice*. The parallel which the sun describes when in that point, is called the *tropic of Cancer*. From the solstice the sun descends again towards the equator, crosses it again at the autumnal equinox, and goes southward till its altitude becomes a minimum. This point of the orbit is called the *winter solstice*. The day is then the shortest of the year, and the parallel which the sun describes, is called the *tropic of Capricorn*. From the winter solstice the sun again approaches the equator, and returns to the vernal equinox.

Such is the constant course of the sun and of the seasons. The interval between the vernal equinox and the summer solstice, is called the *spring*; the interval between this solstice and the autumnal equinox, is called *summer*; that between the autumnal equinox and the winter solstice, is *autumn*; and that between this solstice and the vernal equinox, is *winter*.

The different altitudes of the pole in different climates, occasion remarkable peculiarities in the seasons, with which it is proper to be acquainted. At the equator the poles are situated in the horizon, which last circle cuts all the parallels into two equal parts. Hence the day and the night are constantly of the same length all the year round. On the equinoxes the sun is in the zenith at noon. His altitude is the least possible at the solstices, and is then equal to the complement of the inclination of the ecliptic. During the summer solstice, the shadows of bodies illuminated by the sun are directed towards the south; but they are directed towards the north at the winter solstice; changes which never take place in our northern climates. Under the equator then there are in reality two summers and two winters. The same thing takes place in all countries lying between the tropics. Beyond them there is only one summer and one winter in the year. The sun is never in the zenith. The length of the longest day increases, and that of the shortest day diminishes, as we advance toward the poles; and when the distance between the zenith and the pole is only equal to the inclination of the ecliptic, the sun does not set at all on the days of the summer solstice, nor rise on that of the winter solstice. Still nearer the pole, the period in which he never sets in summer, and never rises in winter, gradually increases from a few days to several months; and, under the pole itself, the equator then coinciding with the horizon, the sun never sets when it is upon the same side of the equator with the pole, and never rises while it is in the opposite side.

The intervals of time between the equinoxes and solstices are not equal. There are about seven days more between the vernal and autumnal equinox, than between the autumnal and vernal. Hence we learn, that the motion of the sun in its orbit is not uniform. Numerous observations, made with precision, have ascertained, that the sun moves fastest in a point of his orbit situated near the winter solstice, and slowest in the opposite point of his orbit near the summer solstice. When in the first point, the sun moves in 24 hours 1°.01943; in the second point, he moves only 0°.95319. The daily motion of the sun is constantly varying in every place of its orbit, between these two points. The medium of the two is 0°.98632, or 59′ 11″, which is the daily motion of the sun about the beginning of October and April. It has been ascertained, that the variation in the angular velocity of the sun, is very nearly proportional to the mean angular distance of it from the point of its orbit, where its velocity is greatest. 45 Motion not uniform.

It is natural to think, that the distance of the sun from the earth varies as well as its angular velocity. This is demonstrated by measuring the apparent diameter of the sun. Its diameter increases and diminishes in the same manner, and at the same time, with its angular velocity; but in a ratio twice as small. About the beginning of January, his apparent diameter is about 32′ 39″, and at the beginning of July it is about 31′ 34″, or more exactly, according to De la Place, 32′ 35″ = 1955″ in the first case, and 31′ 18″ = 1878″ in the second. 46 Diameter varies.

Opticians have demonstrated, that the distance of any body is always reciprocally as its apparent diameter. The sun must follow the same law; therefore, its distance from the earth increases in the same proportion that its apparent diameter diminishes. That point of the orbit in which the sun is nearest the earth, is called *perigeon*, or *perigee*; and the point of the orbit in which that luminary is farthest distant from the earth, is called *apogee*. When the sun is in the first of these points, his apparent diameter is greatest, and his motion swiftest; but when he is in the other point, both his diameter and the rapidity of his motion are the smallest possible. 47 Sun's distance varies.

From these remarks it is obvious that if the orbit of the sun be a circle, the earth is not situated in the centre of that circle, otherwise the distance of the sun from the earth would remain always the same, which is contrary to fact. It is possible therefore, that the variation in his angular velocity may not be *real*, but only apparent. Thus in fig. 3. let AMPN be the orbit

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orbit of the ſun, C the centre of that orbit, and E the poſition of the earth at ſome diſtance from the centre. It is obvious that P is the ſun's perigee, and A its apogee. Now as the ſun's apparent orbit is a circle having the earth in its centre, it is evident that this orbit muſt be AMPN, and that the angular motion of the ſun will be meaſured upon that circle. Suppoſe now that the ſun in his apogee moves from A to A′, it is obvious that his apparent or angular motion will be the ſegment *a a′* of the apparent orbit, conſiderably ſmaller than AA′, ſo that at the apogee the angular motion of the ſun will be leſs than his real motion. Again: let the ſun in his perigee move from P to P′, deſcribing a ſegment preciſely equal to the ſegment AA′. This ſegment as ſeen from the earth will be referred to *p p′*, which in that caſe will be the ſun's angular motion, evidently conſiderably greater than his real motion.

Hence it is obvious that even on the ſuppoſition that the ſun moved equably in his orbit, his angular motion as ſeen from the earth would ſtill vary, that is, would be ſmalleſt at the apogee, and greateſt at the perigee; and that the angular and real motion would only coincide in the points M and N, where the real and apparent orbits cut each other. From the figure it is obvious alſo, that the angular velocity would increaſe gradually from the apogee to the perigee, and diminiſh gradually from the perigee to the apogee, which likewiſe correſponds with obſervation. Now the line EC, which is the diſtance of the earth from the centre of the ſun's orbit, is called the *eccentricity* of that orbit. The variation in the angular motion of the ſun may be owing to this eccentricity.

48 Sun's motion varies.

But if it were owing to this cauſe alone, it is eaſy to demonſtrate that in that caſe the diminution of his angular velocity would follow the ſame ratio as the diminution of his diameter. The fact however is, that the angular velocity diminiſhes in a ratio twice as great as the diameter of the ſun does. The variation of the angular velocity cannot then be owing to the eccentricity alone. Hence it follows, that the variation of the motion of the ſun is not merely apparent, but real; and that its velocity in its orbit actually diminiſhes, as his diſtance from the earth increaſes. Two cauſes then combine to produce the variation in the ſun's angular velocity; namely, 1. The increaſe and diminution of his diſtance from the earth; and 2. The real increaſe and diminution of his velocity in proportion to this variation of diſtance. Theſe two cauſes combine in ſuch a manner that the daily angular motion of the ſun diminiſhes as the ſquare of his diſtance increaſes, ſo that the product of the angular velocity multiplied into the ſquare of the diſtance is a conſtant quantity. But this law is ſo important that it will be neceſſary to be more particular.

The obſervation that the ſun's angular motion in his orbit is inverſely proportional to the ſquare of his diſtance from the earth, was firſt made by Kepler. The diſcovery was made by a careful compariſon of the ſun's diurnal motion with his apparent diameter, which were found to follow that law; and it is evident that the one is the angular motion of the ſun, and the other his diſtance from the earth, which is inverſely proportional to his apparent diameter. Let ASB (fig. 4.) be the ſun's orbit, E the earth, and S the ſun. Suppoſe a line ES joining the centres of the earth and ſun to move round along with the ſun. This line is called the *radius vector*. It is obvious that when S moves to S′, ES, moving along with it, is now in the ſituation ES′, having deſcribed the ſmall ſector ESS′. In the ſame time that S performs one revolution in its orbit, the radius vector ES will deſcribe the whole area ABS, encloſed within the ſun's orbit. Let SS′ be the ſun's angular motion during one day. It is obvious that the ſmall ſector ESS′ is proportional to the ſquare of ES, multiplied by SS′: for the radius vector is the ſun's diſtance from the earth, and SS′ his angular motion. Hence this ſector is a conſtant quantity, whatever the angular motion of the ſun be; and the whole area SEA increaſes as the number of days which the ſun takes in moving from S to A. Hence reſults that remarkable law, firſt pointed out by Kepler, that *the areas deſcribed by the radius vector are proportional to the times*. Suppoſe the ſun to deſcribe SS′ in one day, and SA in 20 days, then the area SES′ is to the area SEA as 1 to 20; or the area SEA is 20 times greater than the area SES′.

49 Deſcribes areas proportional to the times.

The knowledge of theſe facts enables us to draw upon paper, from day to day, lines proportional to the length of the radius vector of the ſolar orbit, and having the ſame relative poſition as theſe lines. If we join the extremity of theſe lines, by making a curve paſs through them, we ſhall perceive that this curve is not exactly circular. Let E in fig. 5. repreſent the the earth, and E*a*, E*b*, E*c*, E*d*, E*f*, &c. the poſition and length of the radius vector during every day of the year: if we join together the points *a*, *b*, *c*, *d*, *e*, *f*, *g*, *h*, *i*, *k*, *l*, *m*, *n*, *o*, by drawing the curve *a e i m*, through them, it is obvious that this curve is not a circle, but elongated towards *a* and *i*, the points which repreſent the ſun's greateſt and leaſt diſtance from the earth. The reſemblance of this curve to the ellipſe induced Kepler to compare them together, and he aſcertained their identity. Hence it follows, that the orbit of the ſun is an *ellipſe*, having the earth in one of its foci. The centre C of the ellipſe is the point where its greater axis is cut perpendicularly by its ſmaller axis. The diſtance CE, between the earth and that centre, is the eccentricity of the ſun's orbit. The eccentricity of this orbit is not great. Let the earth's mean diſtance from the ſun be repreſented by 10,000; it has been aſcertained that the eccentricity is equal to 168 of theſe parts. Hence the ſun's orbit does not differ much from a circle.

50 His orbit an ellipſe.

To form a preciſe notion of the elliptical motion of the ſun, let us ſuppoſe a point to move uniformly in the circumference of a circle, whoſe centre coincides with the centre of the earth, and whoſe radius is equal to the ſun's diſtance from the earth when in his perigee. Let us ſuppoſe alſo, that the ſun and the point ſet out together from the perigee, and that the motion of the point is equal to the ſun's mean angular motion. While the the radius vector of the point moves uniformly round the earth, the radius vector of the ſun moves with unequal velocity, deſcribing always areas proportional to the times. At firſt it gets before the radius vector of the point, and forms with it an angle, which after having increaſed till it reached a certain limit, diminiſhes again and becomes equal to zero, when the ſun is in apogee; then the radius vector of the ſun and of the

point

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point coincide both with each other, and with the greater axis of the ellipse. After passing the apogee the radius vector of the point gets before that of the sun, and forms with it angles exactly equal to the angles formed by the same lines in the former half of the ellipse, at the same distance from the perigee. At the perigee, the radius vector of the sun and of the point again coincide with each other, and with the greater axis of the ellipse. The angle which the radius vector of the sun makes with that of the point, which indicates how much the one precedes the other, is called the *equation of the centre*. It is always greatest when the motions of the point and of the sun are equal, and it vanishes altogether when there is the greatest difference between these motions. The angular motion of the point is called the *mean motion*, and that of the sun the *real motion*. The place of the point in the orbit is called the *mean place*. Now, if to the mean place in the orbit, we add or subtract the equation of the centre, it is obvious that we have the sun's real place for any given time. The angular motion of the point is known with precision for a given time, a day for instance, by ascertaining the exact length of time which the sun takes in making a complete revolution round its orbit. For if we ascertain how many days that revolution requires, we have only to divide the whole orbit by that number to prove the portion of it traversed by the point in one day. The equation of the centre can only be found by approximation. Its maximum in the year 1750 was 1°.9268.

51 Equation of the centre explained.

In computations we begin always at that part of the orbit where the motion of the sun is slowest. The distance of the imaginary point from that part, is called the *mean anomaly*. A table is made of the equation of the centre, corresponding to each degree of the mean anomaly. By adding or subtracting these equations from the mean anomaly, we obtain the true anomaly or place of the sun for any given time.

52 Signs of the zodiac.

The ecliptic is usually divided, by astronomers, into 12 equal parts, called signs, each of which of course contains 30 degrees. They are usually called the signs of the zodiac; and beginning at the equinox, where the sun intersects and rises above the equator, have these names and marks, Aries ♈, Taurus ♉, Gemini ♊, Cancer ♋, Leo ♌, Virgo ♍, Libra ♎, Scorpio ♏, Sagittarius ♐, Capricornus ♑, Aquarius ♒, Pisces ♓. Of these signs, the first six are called *northern*, lying on the north side of the equator; the last six are called *southern*, being situated to the south of the equator. The signs from Capricornus to Gemini are called *ascending*, the sun approaching or rising to the north pole while it passes through them; and the signs from Cancer to Sagittarius are called *descending*, the sun, as it moves through them, receding or descending from the north pole.

The *longitude* of the sun is his distance in the ecliptic from the first point of Aries. His *right ascension* is the arch of the equator intercepted between the first point of Aries, and the meridian circle, which passes through his longitude. The distance of the sun from the equator, measured upon a meridian circle, is called his *declination*, and it is either north or south according to the situation of the sun.

53 Orbit varies in position.

It has been observed that the position of the larger axis of the elliptical orbit of the sun, is not constant. The angular distance of the perigee from the vernal equinox, counted according the sun's movement, was 278°.6211 at the beginning of 1750; but it has, relative to the stars, an annual motion of about 11″.89 in the same direction as the sun.

The orbit of the sun is gradually approaching to the equator. Its obliquity diminishes in a century at the rate of about 1″.50.

The precision of modern astronomers has enabled them to ascertain small irregularities in the sun's elliptical motion, which observation alone would scarcely have been able to bring under precise laws. These irregularities will be considered afterwards.

54 Distance of the sun.

To determine the distance of the sun from the earth, has always been an interesting problem to astronomers, and they have tried every method which astronomy or geometry possesses in order to resolve it. The amplest and most natural, is that which mathematicians employ to measure distant terrestrial objects. From the two extremities of a base whose length is known, the angles which the visual rays from the object, whose distance is to be measured, make with the base, are measured by means of a quadrant; their sum subtracted from 180°, gives the angle which these rays form at the object where they intersect. This angle is called the *parallax*, and when it is once known, it is easy, by means of trigonometry, to ascertain the distance of the object. Let AB, in fig. 6. be the given base, and C the object whose distance we wish to ascertain. The angles CAB and CBA, formed by the rays CA and CB with the base, may be ascertained by observation; and their sum subtracted from 180° leaves the angle ACB, which is the parallax of the object C. It gives us the apparent size of the base AB as seen from C.

When this method is applied to the sun, it is necessary to have the largest possible base. Let us suppose two observers on the same meridian, observing at the same instant the meridian altitude of the centre of the sun, and his distance from the same pole. The difference of the two distances observed, will be the angle under which the line which separates the observers will be seen from the centre of the sun. The position of the observers gives this line in parts of the earth's radius. Hence, it is easy to determine, by observation, the angle at which the semidiameter of the earth would be seen from the centre of the sun. This angle is the sun's *parallax*. But it is too small to be determined with precision by that method. We can only conclude from it, that the sun's distance from the earth is at least equal to 10,000 diameters of the earth. We shall find afterwards, that other methods have been discovered for finding the parallax with much greater precision. It amounts very nearly to 8″.8: hence it follows, that the distance of the sun from the earth amounts to 23,405 semi-diameters of the earth.

Sect. II. *Of the Division of Time.*

Motion is peculiarly adapted for measuring time. For, as a body cannot be in different places in the same time, it can only arrive from one part to another, by passing successively through all the intermediate spaces. And if it be possible to ascertain, that in every point of the line which it describes it is actuated by the very same force, we can conclude with confidence, that it will

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will describe the line with a uniform motion. Of course the different parts of the line will be a measure of the time employed to traverse them. When a pendulum at the end of every oscillation is precisely in the same circumstances, the length of the oscillations is the same, and time may be measured by their number. We might employ also, for the same purpose, the revolutions of the heavenly sphere, which appear perfectly uniform. But all nations have agreed to employ the revolutions of the sun for that purpose.

55 Astronomical day.

In common language, the *day* is the interval of time which elapses from the rising to the setting of the sun; the *night* is the interval that the sun continues below the horizon. The *astronomical day* embraces the whole interval which passes during a complete revolution of the sun. It is the interval of time which passes from 12 o'clock at noon, till the next succeeding noon. It begins when the sun's centre is on the meridian of that place. It is divided into 24 hours, reckoning in a numerical succession from 1 to 24: the first 12 are sometimes distinguished by the mark P. M. signifying *post meridiem*, or after noon; and the latter 12 are marked A. M. signifying *ante meridiem*, or before noon. But astronomers generally reckon through the 24 hours, from noon to noon; and what are by the civil or common way of reckoning called morning hours, are by astronomers reckoned in the succession from 12, or midnight, to 24 hours. Thus 9 o'clock in the morning of February 14th, is, by astronomers, called February the 13th at 21 hours.

56 Sidereal day.

An astronomical day is somewhat greater than a complete revolution of the heavens, which forms a *sidereal day*. For if the sun cross the meridian at the same instant with a star, the day following it will come to the meridian somewhat later than the star, in consequence of its motion eastward, which causes it to leave the star; and after a whole year has elapsed, it will have crossed the meridian just one time less than the star. A sidereal day is less than the solar day, for it is measured by 360°, whereas the mean solar day is measured by 360° 59′ 8″ nearly. If an astronomical day be $=1$, then a sidereal day is $=0.997269722$; or the difference between the measures of a mean solar day, and a sidereal day, viz. 59′ 8″, reduced to time, at the rate of 24 hours to 360°, gives 3′ 56″; from which we learn that a star which was on the meridian with the sun on one noon, will return to that meridian 3′ 56″ previous to the next noon: therefore, a clock which measures mean days by 24 hours, will give 23 h. 56 m. 4 sec. for the length of a sidereal day.

57 Days vary in length.

Astronomical or solar days, as they are also called, are not equal. Two causes conspire to produce their inequality, namely, the unequal velocity of the sun in his orbit, and the obliquity of the ecliptic. The effect of the first cause is sensible. At the summer solstice, when the sun's motion is slowest, the astronomical day approaches nearer the sidereal, than at the winter solstice when his motion is most rapid.

To conceive the effect of the second cause, it is necessary to recollect that the excess of the astronomical day above the sidereal is owing to the motion of the sun, referred to the equator. The sun describes every day a small arch of the ecliptic. Through the extremities of this arch suppose two meridian great circles drawn, the arc of the equator, which they intercept, is the sun's motion for that day referred to the equator; and the time which that arc takes to pass the meridian is equal to the excess of the astronomical day above the sidereal. But it is obvious, that at the equinoxes, the arc of the equator is smaller than the corresponding arc of the ecliptic in the proportion of the cosine of the obliquity of the ecliptic to radius: at the solstices, on the contrary, it is greater in the proportion of radius to the cosine of the same obliquity. The astronomical day is diminished in the first case, and lengthened in the second.

To have a mean astronomical day, independent of these causes of inequality, astronomers have supposed a second sun to move uniformly on the ecliptic, and to pass over the extremities of the axis of the sun's orbit, at the same instant with the real sun. This removes the inequality arising from the inequality of the sun's motion. To remove the inequality arising from the obliquity of the ecliptic, astronomers suppose a third sun passing through the equinoxes at the same instant with the second sun, and moving along the equator in such a manner that the angular distances of the two suns at the vernal equinox shall be always equal. The interval between two consecutive returns of this third sun to the meridian forms the *mean astronomical day*. *Mean time* is measured by the number of the returns of this third sun to the meridian; and true time is measured by the returns of the real sun to the meridian. The arc of the equator, intercepted between two meridian circles drawn through the centres of the true sun, and the imaginary third sun, reduced to time, is what is called the *equation of time*. This will be rendered plainer by the following diagram.

58 Mean astronomical day.

Let Z♈z♎ (fig. 7.) be the earth; ZFRz, its axis; *abcde*, &c. the equator; ABCDE, &c. the northern half of the ecliptic from ♈ to ♎, on the side of the globe next the eye; and MNOP, &c. the southern half on the opposite side from W to ♈. Let the points at A, B, C, D, E, F, &c. quite round from ♈ to ♈ again bound equal portions of the ecliptic, gone through in equal times by the real sun; and those at *a*, *b*, *c*, *d*, *e*, *f*, &c. equal portions of the equator described in equal times by the fictitious sun; and let Z♈z be the meridian.

As the real sun moves obliquely in the ecliptic, and the fictitious sun directly in the equator, with respect to the meridian; a degree, or any number of degrees, between ♈ and F on the ecliptic, must be nearer the meridian Z♈z, than a degree, or any corresponding number of degrees, on the equator from ♈ to *f*; and the more so, as they are the more oblique: and therefore the true sun comes sooner to the meridian every day whilst he is in the quadrant ♈ F, than the fictitious sun does in the quadrant ♈ *f*; for which reason, the solar noon precedes noon by the clock, until the real sun comes to F, and the fictitious to *f*; which two points, being equidistant from the meridian, both suns will come to it precisely at noon by the clock.

Whilst the real sun describes the second quadrant of the ecliptic FGHIKL from Cancer to ♎, he comes later to the meridian every day than the fictitious sun moving through the second quadrant of the equator from *f* to ♎; for the points at G, H, I, K, and L, being farther from the meridian, their corresponding points at *g*, *h*, *i*, and *l*, must be later of coming to it:

and

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and as both ſuns come at the ſame moment to the point W, they come to the meridian at the moment of noon by the clock.

In departing from Libra, through the third quadrant, the real ſun going through MNOPQ towards ♑ at R, and the fictitious ſun through *mnopq* towards *r*, the former comes to the meridian every day ſooner than the latter, until the real ſun comes to ☉, and the fictitious to *r*, and then they come both to the meridian at the ſame time.

Laſtly, As the real ſun moves equably through STUVW, from ☉ towards ♈; and the fictitious ſun through *stuvw*, from *r* towards ♈, the former comes later every day to the meridian than the latter, until they both arrive at the point ♈, and then they make it noon at the ſame time with the clock.

Having explained one cauſe of the difference of time ſhown by a well-regulated clock and a true ſun-dial, ſuppoſing the ſun, not the earth, as moving in the ecliptic; we now proceed to explain the other cauſe of this difference, namely, the inequality of the ſun's apparent motion; which is ſloweſt in ſummer, when the ſun is fartheſt from the earth, and ſwifteſt in winter when he is neareſt to it.

If the ſun's motion were equable in the ecliptic, the whole difference between the equal time as ſhown by the clock, and the unequal time as ſhown by the ſun, would ariſe from the obliquity of the ecliptic. But the ſun's motion ſometimes exceeds a degree in 24 hours, though generally it is leſs: and when his motion is ſloweſt, any particular meridian will revolve ſooner to him than when his motion is quickeſt; for it will overtake him in leſs time when he advances a leſs ſpace than when he moves through a larger.

Now, if there were two ſuns moving in the plane of the ecliptic, ſo as to go round it in a year; the one deſcribing an equal arc every 24 hours, and the other deſcribing ſometimes a leſs arc in 24 hours, and at other times a larger, gaining at one time of the year what it loſt at the oppoſite; it is evident, that either of theſe ſuns would come ſooner or later to the meridian than the other, as it happened to be behind or before the other; and when they were both in conjunction, they would come to the meridian at the ſame moment.

As the real ſun moves unequably in the ecliptic, let us ſuppoſe a fictitious ſun to move equably in a circle coincident with the plane of the ecliptic. Let ABCD (fig. 8.) be the ecliptic or orbit in which the real ſun moves, and the doted circle *abcd* the imaginary orbit of the fictitious ſun; each going round in a year according to the order of letters, or from weſt to eaſt. Let HIKL be the earth turning round its axis the ſame way every 24 hours; and ſuppoſe both ſuns to ſtart from A and *a*, in a right line with the plane of the meridian EH, at the ſame moment: the real ſun at A, being then at his greateſt diſtance from the earth, at which time his motion is ſloweſt; and the fictitious ſun at *a*, whoſe motion is always equable, becauſe his diſtance from the earth is ſuppoſed to be always the ſame. In the time that the meridian revolves from H to H again, according to the order of the letters HIKL, the real ſun has moved from A to F; and the fictitious with a quicker motion from *n* to *f*, through a large arc: therefore, the meridian EH will revolve ſooner from H to *h* under the real ſun at F, than from HE to *k* under the fictitious ſun at *f*; and conſequently it will then be noon by the ſun-dial ſooner than by the clock.

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As the real ſun moves from A towards C, the ſwiftneſs of his motion increaſes all the way to C, where it is at the quickeſt. But notwithſtanding this, the fictitious ſun gains ſo much upon the real, ſoon after his departing from A, that the increaſing velocity of the real ſun does not bring him up with the equally-moving fictitious ſun till the former comes to C, and the latter to *c*, when each has gone half round its reſpective orbit; and then being in conjunction, the meridian EH, revolving to EK, comes to both ſuns at the ſame time, and therefore it is noon by them both at the ſame moment.

But the increaſed velocity of the real ſun now being at the quickeſt, carries him before the fictitious one; and therefore, the ſame meridian will come to the fictitious ſun ſooner than to the real: for whilſt the fictitious ſun moves from *a* to *g*, the real ſun moves through a greater arc from C to G: conſequently the point K has its noon by the clock when it comes to *k*, but not its noon by the ſun till it comes to *l*. And although the velocity of the real ſun diminiſhes all the way from C to A, and the fictitious ſun by an equable motion is ſtill coming nearer to the real ſun, yet they are not in conjunction till the one comes to A and the other to *a*, and then it is noon by them both at the ſame moment.

True time is obtained by adding or ſubtracting this equation to the mean time. The mean and apparent ſolar days are never equal, except when the ſun's daily motion in right aſcenſion is 59′ 8″; this is nearly the caſe about April 15th, June 15th, September 1ſt, and December 24th: on theſe days the equation is nothing, or nearly ſo; it is at the greateſt about November 1ſt, when it is 16 m. 14 ſec.

The return of the ſun to the ſame equinox marks the years, in the ſame way as his return to the ſame meridian indicates the days. It has been aſcertained, that before the ſun returns again to the ſame equinox, an interval of 365.242222 days elapſes, or 365 days, 5 hours, 48 minutes, and 47 ſeconds. This is called the *tropical year*: The ſun takes a larger interval of time to return again to the ſame ſtar. The *ſidereal year* is the interval which the ſun employs to return from one ſtar to another. It is greater than the tropical year by 0.014162 days, or 20 m. 23 ſec.; therefore the length of the ſidereal year is 365 days, 6 h. 9 m. and 10 ſec. From this it follows, that the equinoxes do not retain the ſame place in the ecliptic, but that they have a retrograde motion, or contrary to that of the ſun, in conſequence of which they deſcribe every year an arc equal to the mean ſpace which the ſun paſſes over in 20′ 23″, or about 50″; ſo that they would make a complete revolution in 25972 years. This is called the *preceſſion of the equinoxes*. 59 Year.

Dr Maſkelyne has invented a rule for computing the equation of time, in which the preceſſion of the equinoxes, as well as the two cauſes mentioned above, are included. Let APLQ, fig. 9. be the ecliptic, ALQ the equator, A the firſt point of Aries, P the point where the ſun's apparent motion is ſloweſt, S any place of the ſun; draw S*v* perpendicular to the equator, 60 Method of computing the equation of time.

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equator, and take $An = AP$. When the sun begins to move from P, suppose a star to begin to move from n with the sun's mean motion in right ascension or longitude, viz. at the rate of 59′ 8″ in a day, and when n passes the meridian let the clock be adjusted to 12. Take $nm = Ps$, and when the star comes to m, if the sun moved uniformly with his mean motion, he would be found at s; but at that time let S be the place of the sun. Let the sun S, and consequently v, be on the meridian; and then as m is the place of the imaginary star at that instant, mv must be the equation of time. The sun's mean place is at s, and as $An = AP$, and $nm = Ps$, we have $Am = APs$, consequently $mv = Av - Am = Av - APs$. Let a be the mean equinox, or the point where it would have been if it had moved with its mean velocity, and draw az perpendicular to AQ; then $Am = Az + xm = Aa \times$ co-sine $zAa + zm$: or because the co-sine of zAa the obliquity of the ecliptic, 23° 28′, is $= \frac{11}{12}$ very nearly, $Am = \frac{11}{12} Aa + xm$: hence $mv = Av - zm - \frac{11}{12} Aa$. Here Av is the sun's true right ascension, zm the mean right ascension or mean longitude; and $\frac{11}{12} Aa$ (viz. Ax) is the equation of the equinoxes in right ascension; therefore the equation of time is equal to the difference of the sun's true right ascension and his mean longitude, corrected by the equation of the equinoxes in right ascension.—When Am is less than Av, mean or true time precedes apparent; when it is greater, apparent time precedes mean. That is, when the sun's true right ascension is greater than his mean longitude corrected as above shewn, we must add the equation of time to the apparent to obtain the mean time; and when it is less, we must subtract. To convert mean time into apparent, we must subtract in the former case, and add in the latter.

Tables of the equation of time are computed by this rule, for the use of astronomers: they are either calculated for the noon of each day, as given in the Nautical and some other almanacks; or for every degree of the sun's place in the ecliptic. But a table of this kind will not answer accurately for many years, on account of the precession and other causes, which render a frequent revisal of the calculations necessary.

61 Smaller divisions of time.

The smaller divisions of time were anciently measured by the phases of the moon. It is well known that the moon changes once every 29 or 30 days, and that the interval from one new moon to another is called a *lunation*, or in, common language, a *month*. There are about twelve lunations in a year. Hence the year was divided into twelve months. In ancient times people were placed upon eminences on purpose to watch the first appearance of the new moon when their month began. It was customary for these persons to proclaim the first appearance of the moon. Hence the first day of every month was called *Calendæ*; from which term the word calendar is derived. Almost all nations have divided the year into twelve months, because the seasons nearly return in that period. But they soon perceived that twelve lunar months were far from making a complete year or revolution of the sun. They were anxious, however, to be able to divide the solar year into a precise number of lunar months, because many of their feasts depended upon particular new moons. Various contrivances were fallen upon for this purpose without much success, till at last Meton, a Greek philosopher, announced that 19 years contained exactly 235 lunations: an affirmation which is within 2½ hours of being exact. To make every year correspond as nearly as possible to the lunar, he divided the year into 12 months, consisting alternately of 30 and 29 days each; at the end of every three years an intercalary month of 30 days was added, and at the end of the 19th year there was added an intercalary month of 29 days. So that at the end of 19 years the solar and lunar years began again on the same day their cycle of 19 years. This discovery of Meton appeared so admirable to the Greeks, that they engraved it in letters of gold in their public places. Hence the number which denotes the current year of that cycle is denominated *golden number*.

As the moon changes its appearance in a very remarkable degree every seven days, almost all nations have subdivided the month into periods of seven days, called *weeks*; the ancient Greeks were almost the only people who did not employ that division.

62 Roman year.

The Roman year in the time of Romulus consisted of 10 months only, of 30 or 31 days each, so that its length was 304 days only. Numa added 50 days to that year, and thus made it 354 days; and he added two additional months of 29 and 28 days, by shortening some of the ancient months. He made the year commence on the first of January. Numa's year was still more than 11 days shorter than a complete revolution of the sun. To make it correspond with the seasons, it was necessary to intercalate three days; and these intercalations being left entirely to the priests, were converted into a state engine; being omitted, inserted, altered, and varied, as it suited the purposes of those magistrates whose views they favoured. The consequence was, what might have been expected, the most complete confusion and want of correspondence between the year and the seasons.

63 Reformed by Julius Cæsar,

Julius Cæsar undertook to remedy this inconvenience. He was both dictator and high pontiff, and of course the reformation of the calendar was his peculiar province. That the undertaking might be properly executed, he invited Sosigenes, an Egyptian mathematician, to come to his assistance. It was agreed upon to abandon the motions of the moon altogether, and to make the year correspond with those of the sun.

The reformation was made in the year 47 before the Christian era. Ninety days were added to that year, which was from that circumstance called *the year of confusion*, consisting of 445 days. Instead of 354 days, the year of Numa, Sosigenes made the year to consist of 365 days, dispersing the additional days among those months which had only 29 days. As the revolution of the sun employs nearly six hours more than 365 days, an additional day was intercalated every fourth year, so that every such year was to consist of 366 days. The additional day was inserted after the 23d of February, or the 7th before the calends of March; the day before the annual feast celebrated in commemoration of the flight of Tarquin from Rome. That feast was held the 6th before the calends of March.

The

The intercalated day was alſo called the 6th before the calends of March. So that every fourth year there were two days denominated the 6th before the calends of March. Hence that year was called *biſſextile*. In Britain it is denominated *leap year*. After the death of Julius Cæſar there was a degree of confuſion reſpecting the intercalations, from the ignorance of the prieſts. Auguſtus corrected the miſtake, and after that time the Julian period went on without any interruption.

It is obvious that the Julian year, though a great improvement upon the ancient Roman, was ſtill imperfect. It went on the ſuppoſition that the revolution of the ſun occupied preciſely 365 days and 6 hours, which is about 11 minutes more than the truth. This error in the interval which elapſed between the reformation of Julius Cæſar and the year 1582, had accumulated till it amounted to 10 days; of courſe the year began 10 days later than it ought to have begun; and the ſame error had taken place reſpecting the ſeaſons and the equinoctial points. Various attempts had been

64 made to correct this error; at laſt it was corrected by Pope Gregory XIII. The Gregorian calendar commenced in the year 1582; the changes which he introduced were two in number. He ordered, that after the 4th of October 1582, ten days ſhould be omitted, ſo that the day which ſucceeded the 4th was reckoned not the 5th but the 15th of the month. This corrected the error which had crept into the Julian year. To prevent any ſuch error from accumulating again, he ordered that the ſecular years 1700, 1800, 1900, ſhould not be biſſextile but common years; that the ſecular year 2000 ſhould be biſſextile, the next three ſecular years common, the fourth again biſſextile, and ſo on, as in the following table.

and by Gregory XIII.

1600 biſſextile.	2100 common.	2600 common.
1700 common.	2200 ib.	2700 ib.
1800 ib.	2300 ib.	2800 biſſextile.
1900 ib.	2400 biſſextile.	2900 common.
2000 biſſextile.	2500 common.	3000 ib.

In ſhort theſe ſecular years only are biſſextile whoſe number, omitting the cyphers, is diviſible by 4.

The Gregorian calendar is ſufficiently exact for the purpoſes of common life, though it does not correſpond preciſely with the revolution of the ſun. The error will amount to a day in 3600 years, ſo that in the year 5200 it will be neceſſary to omit the additional day which ought to be added according to the rule laid down above.

The Gregorian calendar was immediately adopted by all the Roman Catholic kingdoms in Europe, but the Proteſtant ſtates refuſed at firſt to accede to it. It was adopted by moſt of them on the continent about the beginning of the 18th century; but in England the change did not take place till 1752. From that year 11 days were omitted; the omiſſion of the additional day in 1700 having made the difference between the Julian and Gregorian calendar amount to 11 days. The Julian calendar is called the *old ſtyle*, the Gregorian, the *new ſtyle*. At preſent the difference between them is 12 days, in conſequence of the omiſſion of the additional day in 1800.

SECT. III. *Of the Nature of the Sun.*

THE ſmallneſs of the ſun's parallax is a demonſtration of its immenſe ſize. We are certain that at the diſtance at which the ſun appears to us under an angle of 0°.53424 the earth would be ſeen under an angle not exceeding 0°.009. Now, as the ſun is obviouſly a ſpherical body as well as the earth; and as ſpheres are to each other as the cubes of their diameters, it follows from this, that the ſun is at leaſt 200,000 times bigger than the earth. By the exacteſt obſervations it has been aſcertained, that the diameter of the ſun is nearly 883,000 miles.

Dark ſpots are very frequently obſerved upon the ſurface of the ſun. Theſe were entirely unknown before the invention of teleſcopes, though they are ſometimes of ſufficient magnitude to be diſcerned by the naked eye, only looking through a ſmoked glaſs to prevent the brightneſs of the luminary from deſtroying the ſight. The ſpots are ſaid to have been firſt diſcovered 65
in the year 1611; and the honour of the diſcovery is diſputed betwixt Galileo and Scheiner, a German Jeſuit at Ingolſtadt. But whatever merit Scheiner might have in the priority of the diſcovery, it is certain that Galileo far exceeded him in accuracy, though the work of Scheiner has conſiderable merit, as containing obſervations ſelected from above 3000, made by himſelf. Since his time the ſubject has been carefully ſtudied by all the aſtronomers in Europe.

Solar ſpots when firſt diſcovered.

There is great variety in the magnitudes of the 66
ſolar ſpots; the difference is chiefly in ſuperficial extent of length and breadth; their depth or thickneſs is very ſmall; ſome have been ſo large, as by computation to be capable of covering the continents of Aſia and Africa; nay, the whole ſurface of the earth, or even five times its ſurface. The diameter of a ſpot, when near the middle of the diſk, is meaſured by comparing the time it takes in paſſing over a croſs hair in a teleſcope, with the time wherein the whole diſk of the ſun paſſes over the ſame hair; it may alſo be meaſured by the micrometer; and by either of theſe methods we may judge how many times the diameter of the ſpot is contained in the diameter of the ſun. Spots are ſubject to increaſe and diminution of magnitude, and ſeldom continue long in the ſame ſtate. They are of various ſhapes; moſt of them having a deep black nucleus ſurrounded by a duſky cloud, whereof the inner parts near the black are a little brighter than the outſkirts. They change their ſhapes, ſomething in the manner that our clouds do; though not often ſo ſuddenly: thus, what is of a certain figure to-day, ſhall to-morrow, or perhaps in a few hours, be of a different one; what is now but one ſpot, ſhall in a little time be broken into two or three; and ſometimes two or three ſpots ſhall coaleſce, and be united into one. Dr Long, many years ſince, while he was viewing the image of the ſun through a teleſcope caſt upon white paper, ſaw one roundiſh ſpot, by eſtimation not much leſs than the diameter of our earth, break into two, which receded from one another with prodigious velocity. This obſervation was ſingular at the time; for though ſeveral writers had taken notice of this after it was done, none of them had been making any obſervation at the time it was actually doing.

Dr Long's account of them.

The number of ſpots on the ſun is very uncertain; ſometimes there are a great many, ſometimes very few; and ſometimes none at all. Scheiner made obſervations on the ſun from 1611 to 1629; and ſays he never found his diſk quite free of ſpots, excepting a few days in December 1624. At other times he frequently ſaw 20, 30, and in the year 1625 he was able to count 50 ſpots on the ſun at a time. In an interval afterwards of 20 years, from 1650 to 1670, ſcarce any ſpots were to be ſeen, and ſince that time ſome years have furniſhed a great number of ſpots, and others none at all; but ſince the beginning of the laſt century, not a year paſſed wherein ſome were not ſeen; and at preſent, ſays Mr Caſſini, in his *Elemens d'Aſtronomie* publiſhed in 1740, they are ſo frequent, that the ſun is ſeldom without ſpots, and often ſhows a good number of them at a time.

From theſe phenomena, it is evident, that the ſpots are not endowed with any permanency; nor are they at all regular in their ſhape, magnitude, number, or in the time of their appearance or continuance. Hevelius obſerved one that aroſe and vaniſhed in 16 or 17 hours; nor has any been obſerved to continue longer than 70 days, which was the duration of one in the year 1676. Thoſe ſpots that are formed gradually, are gradually diſſolved; while thoſe that ariſe ſuddenly, are for the moſt part ſuddenly diſſolved. When a ſpot diſappears, that part where it was generally becomes brighter than the reſt of the ſun, and continues ſo for ſeveral days: on the other hand, thoſe bright parts (called *faculæ*, as the others are called *maculæ*) ſometimes turn to ſpots.

67 The ſolar ſpots move from weſt to eaſt.

The ſolar ſpots appear to have a motion which carries them acroſs the ſun's diſk. Every ſpot, if it continues long enough without being diſſolved, appears to enter the ſun's diſk on the eaſt ſide, to go from thence with the velocity continually increaſing till it has gone half its way; and then to move ſlower and ſlower, till it goes off at the weſt ſide; after which it diſappears for about the ſame ſpace of time that it ſpent in croſſing the diſk, and then enters upon the eaſt ſide again, nearly in the ſame place, and croſſes it in the ſame tract, and with the ſame unequal motion as before. This apparent inequality in the motion of the ſpots is purely optical, and is in ſuch proportion as demonſtrates them to be carried round equably or in a circle, the plane of which continued paſſes through or near the eye of a ſpectator upon the earth.

Beſides the real changes of the ſpots already mentioned, there is another which is purely optical, and is owing to their being ſeen on a globe differently turned towards us. If we imagine the globe of the ſun to have a number of circles drawn upon its ſurface, all paſſing through the poles, and cutting his equator at equal diſtances, theſe circles which we may call meridians, if they were viſible, would appear to us at unequal diſtances, as in fig. 2. Now, ſuppoſe a ſpot were round, and ſo large as to reach from one meridian to another, it would appear round only at *g*, when it was in the middle of that half of the globe which is towards our earth; for then we view the full extent of it in length and breadth: in every other place it turns away from us, and appears narrower, though of the ſame length, the farther it is from the middle; and on its coming on at *a*, and going off at *n*, it appears as ſmall as a thread, the thin edge being then all that we ſee.

Theſe ſpots have made us acquainted with a very important phenomenon, namely the *rotation* of the ſun upon its axis. Amidſt the changes which theſe ſpots are continually undergoing, regular motions may be detected, agreeing exactly with the motion of the ſurface of the ſun, on the ſuppoſition that this luminary revolves round an axis almoſt perpendicular to the ecliptic in the ſame direction with its motion in its orbit round the earth. By a careful examination of the motion of theſe ſpots, it has been aſcertained that the ſun turns round its axis in about 25 days and a half, and that its equator is inclined to the ecliptic about 7°.5.

The ſpots on the ſun's diſk are almoſt always confined to a zone, extending about 30°.5 on each ſide of the equator. Sometimes, however, they have been obſerved at the diſtance of 39.°5 from the equator of the ſun.

Bouguer demonſtrated, by a number of curious experiments on the ſun's light, that the intenſity of the light is much greater toward the centre of the ſun's diſk than towards its circumference. Now, when a portion of the ſun's ſurface is tranſported by the rotation of that luminary from the centre to the circumference of his diſk, as it is ſeen under a ſmaller angle, the intenſity of its light, inſtead of diminiſhing, ought to increaſe. Hence it follows, that part of the light which iſſues from the ſun towards the circumference of his diſk, muſt be ſomehow or other prevented from making its way to the earth. This cannot be accounted for, without ſuppoſing that the ſun is ſurrounded by a denſe atmoſphere, which, being traverſed obliquely by the rays from the circumference, intercepts more of them than of thoſe from the centre which paſs it perpendicularly.

68 Account of their phenomena by different obſervers.

The phenomena of the ſolar ſpots, as delivered by Scheiner and Hevelius, may be ſummed up in the following particulars. 1. Every ſpot which hath a nucleus, or conſiderably dark part, hath alſo an umbra, or fainter ſhade, ſurrounding it. 2. The boundary betwixt the nucleus and umbra is always diſtinct and well defined. 3. The increaſe of a ſpot is gradual, the breadth of the nucleus and umbra dilating at the ſame time. 4. In like manner, the decreaſe of a ſpot is gradual, the breadth of the nucleus and umbra contracting at the ſame time. 5. The exterior boundary of the umbra never conſiſts of ſharp angles; but is always curvilinear, how irregular ſoever the outline of the nucleus may be. 6. The nucleus of a ſpot, whilſt on the decreaſe, often changes its figure by the umbra encroaching irregularly upon it, inſomuch that in a ſmall ſpace of time new encroachments are diſcernible, whereby the boundary betwixt the nucleus and umbra is perpetually varying. 7. It often happens, by theſe encroachments, that the nucleus of a ſpot is divided into two or more nuclei. 8. The nuclei of the ſpots vaniſh ſooner than the umbra. 9. Small umbræ are often ſeen without nuclei. 10. An umbra of any conſiderable ſize is ſeldom ſeen without a nucleus in the middle of it. 11. When a ſpot which conſiſted of a nucleus and umbra is about to diſappear, if it is not ſuc-

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ceeded by a *facula*, or ſpot brighter than the reſt of the diſk, the place where it was is ſoon after not diſtinguiſhable from the reſt.

In the Philoſophical Tranſactions, vol. lxiv. Dr Wilſon, profeſſor of aſtronomy at Glaſgow, hath given a diſſertation on the nature of the ſolar ſpots, and mentions the following appearaces. 1. When the ſpot is about to diſappear on the weſtern edge of the ſun's limb, the eaſtern part of the umbra firſt contracts, then vaniſhes, the nucleus and weſtern part of the umbra remaining; then the nucleus gradually contracts and vaniſhes, while the weſtern part of the umbra remains. At laſt this diſappears alſó; and if the ſpot remains long enough to become again viſible, the eaſtern part of the umbra firſt becomes viſible, then the nucleus; and when the ſpot approaches the middle of the diſk, the nucleus appears environed by the umbra on all ſides, as already mentioned. 2. When two ſpots lie very near to one another, the umbra is deficient on that ſide which lies next to the other ſpot: and this will be the caſe, though a large ſpot ſhould be contiguous to one much ſmaller; the umbra of the large ſpot will be totally wanting on that ſide next the ſmall one. If there are little ſpots on each ſide of the large one, the umbra does not totally vaniſh; but appears flattened or preſſed in towards the nucleus on each ſide. When the little ſpots diſappear, the umbra of the large one extends itſelf as uſual. This circumſtance, he obſerves, may ſometimes prevent the diſappearance of the umbra in the manner above mentioned; ſo that the weſtern umbra may diſappear before the nucleus, if a ſmall ſpot happens to break out on that ſide.

In the ſame volume. p. 337. Mr Wollaſton obſerves, that the appearances mentioned by Dr Wilſon are not conſtant. He poſitively affirms, that the faculæ or bright ſpots on the ſun are often converted into dark ones. "I have many times (ſays he) obſerved, near the eaſtern limb, a bright facula juſt come on, which has the next day ſhown itſelf as a ſpot, though I do not recollect to have ſeen ſuch a facula near the weſtern one after a ſpot's diſappearance. Yet, I believe, both theſe circumſtances have been obſerved by others; and perhaps not only near the limbs. The circumſtance of the faculæ being converted into ſpots, I think I may be ſure of. That there is generally (perhaps always) a mottled appearance over the face of the ſun, when carefully attended to, I think I may be as certain. It is moſt viſible towards the limbs, but I have undoubtedly ſeen it in the centre; yet I do not recollect to have obſerved this appearance, or indeed any ſpots, towards the poles. Once I ſaw, with a twelve-inch reflector, a ſpot burſt to pieces while I was looking at it. I could not expect ſuch an event, and therefore cannot be certain of the exact particulars; but the appearance, as it ſtruck me at the time, was like that of a piece of ice when daſhed on a frozen pond, which breaks to pieces and ſlides in various directions." He alſo acquaints us, that the nuclei of the ſpots are not always in the middle of the umbræ; and gives the figure of one ſeen in November 13th 1773, which is a remarkable inſtance to the contrary.

69 Mr Dunn's account.

Mr Dunn, however, in his new Atlas of the Mundane Syſtem, gives ſome particulars very different from the above. "The face of the ſun (ſays he) has frequently many large black ſpots, of various forms and dimenſions, which move from eaſt to weſt, and round the ſun, according to ſome obſervations in 25 days, according to others in 26, and according to ſome in 27 days. The black or central part of each ſpot is in the middle of a great number of very ſmall ones, which permit the light to paſs between them. The ſmall ſpots are ſcarce ever in contact with the central ones: but, what is moſt remarkable, when the whole ſpot is near the limb of the ſun, the ſurrounding ſmall ones form nearly a ſtraight line, and the central part projects a little over it, like Saturn in his ring."

70 Herſchel's obſervations.

Dr Herſchel, with a view of aſcertaining more accurately the nature of the ſun, made frequent obſervations upon it from the year 1779 to the year 1794. He imagines that the dark ſpots on the ſun are mountains on its ſurface, which, conſidering the great attraction exerted by the ſun upon bodies placed at its ſurface, and the ſlow revolution it has upon its axis, he thinks may be more than 300 miles high, and yet ſtand very firmly. He ſays, that in Auguſt, 1792, he examined the ſun with ſeveral powers from 90 to 500; and it evidently appeared that the dark ſpots are the opaque ground or body of the ſun; and that the luminous part is an atmoſphere, which, being intercepted or broken, gives us a view of the ſun itſelf. Hence he concludes, that the ſun has a very extenſive atmoſphere, which conſiſts of elaſtic fluids that are more or leſs lucid and tranſparent; and of which the lucid ones furniſh us with light. This atmoſphere, he thinks, is not leſs than 1843, nor more than 2765 miles in height; and, he ſuppoſes, that the denſity of the luminous ſolar clouds need not be much more than that of our aurora borealis, in order to produce the effects with which we are acquainted. The ſun then, if this hypotheſis be admitted, is ſimilar to the other globes of the ſolar ſyſtem, with regard to its ſolidity—its atmoſphere—its ſurface diverſified with mountains and valleys—its rotation on its axis—and the fall of heavy bodies on its ſurface; it therefore appears to be a very eminent, large, and lucid planet, the primary one in our ſyſtem, diſſeminating its light and heat to all the bodies with which it is connected.

Dr Herſchel has lately given up the uſe of the old terms ſuch as *ſpots*, *nuclei*, *penumbræ*, &c. and has introduced a number of new terms, which he conſiders as more preciſe. It will be neceſſary, before we proceed farther, to inſert his explanation of theſe terms.

71 Explanation of his terms.

"The expreſſions," ſays he, "which I have uſed are *openings*, *ſhallows*, *ridges*, *nodules*, *corrugations*, *indentations*, and *pores*.

"*Openings* are thoſe places where, by the accidental removal of the luminous clouds of the ſun, its own ſolid body may be ſeen; and this not being lucid, the openings through which we ſee it may, by a common teleſcope, be miſtaken for mere black ſpots, or their nuclei.

"*Shallows* are extenſive and level depreſſions of the luminous ſolar clouds, generally ſurrounding the openings to a conſiderable diſtance. As they are leſs luminous than the reſt of the ſun, they ſeem to have ſome diſtant, though very imperfect reſemblance to penumbræ; which might occaſion their having been called ſo formerly.

"*Ridges* are bright elevations of luminous matter, extended in rows of an irregular arrangement.

"*Nodules* are alſo bright elevations of luminous matter,

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ter, but confined to a ſmall ſpace. Theſe nodules, and ridges, on account of their being brighter than the general ſurface of the ſun, and alſo differing a little from it in colour, have been called faculæ, and luculi.

"*Corrugations*, I call that very particular and remarkable unevenneſs, ruggedneſs, or aſperity, which is peculiar to the luminous ſolar clouds, and extends all over the ſurface of the globe of the ſun. As the depreſſed parts of the corrugations are leſs luminous than the elevated ones, the diſk of the ſun has an appearance which may be called mottled.

Indentations are the depreſſed or low parts of the corrugations; they alſo extend over the whole ſurface of the luminous ſolar clouds.

Pores are very ſmall holes or openings, about the middle of the indentations.

From the numerous obſervations of this philoſopher he has drawn the following concluſions :—

72 Openings.

1. Openings are places where the luminous clouds of the ſun are removed: large openings have generally ſhallows about them; but ſmall openings are generally without ſhallows. They have generally ridges and nodules about them, and they have a tendency to run into each other. New openings often break out near other openings. Hence he ſuppoſes that the openings are occaſioned by an elaſtic but not luminous gas, which comes up through the pores and incipient openings, and ſpreads itſelf on the luminous clouds, forcing them out of its way, and widening its paſſage. Openings ſometimes differ in colour; they divide when decayed; ſometimes they increaſe again; but when divided they uſually decreaſe and vaniſh; ſometimes they become large indentations, and ſometimes they turn into pores.

73 Shallows.

2. Shallows are depreſſed below the general ſurface of the ſun, and are places from which the luminous ſolar clouds of the upper regions are removed. Their thickneſs is viſible; ſometimes they exiſt without openings in them. Incipient ſhallows come from the openings, or branch out from ſhallows already formed, and go forward. He ſuppoſes that the ſhallows are occaſioned by ſomething coming out of the openings, which, by its propelling motion, drives away the luminous clouds from the place where it meets with the leaſt reſiſtance; or which, by its nature, diſſolves them as it comes up to them. If it be an elaſtic gas, its levity muſt be ſuch as to make it aſcend through the inferior region of the ſolar clouds, and diffuſe itſelf among the ſuperior luminous matter.

74 Ridges.

3. Ridges are elevations above the general ſurface of the luminous clouds of the ſun. One of them, which he meaſured, extended over an angular ſpace of 2′ 45″.9, which is nearly 75,000 miles.

Ridges generally accompany openings: but they often alſo exiſt in places where there are no openings. They uſually diſperſe very ſoon. He ſuppoſes, that the openings permit a tranſparent elaſtic fluid to come out, which diſturbs the luminous matter on the top, ſo as to occaſion ridges and nodules; or, more preciſely, that ſome elaſtic gas, acting below the luminous clouds, lifts them up, or increaſes them; and at laſt forces itſelf a paſſage through them, by throwing them aſide.

75 Nodules.

4. Nodules are ſmall, but highly elevated luminous places. He thinks that they may be ridges fore-ſhortened.

5. Corrugations conſiſt of elevations and depreſſions. They extend all over the ſurface of the ſun; they change their ſhape and ſituation; they increaſe, diminiſh, divide, and vaniſh quickly. Diſperſed ridges and nodules form corrugations.

76 Pores.

6. The dark places of corrugations are indentations. Indentations are uſually without openings, though in ſome places they contain ſmall ones. They change to openings, and are of the ſame nature as ſhallows. They are low places, which often contain very ſmall openings. They are of different ſizes, and are extended all over the ſun. With low magnifying powers they appear like points. The low places of indentations are *pores*. Pores increaſe ſometimes, and become openings: they vaniſh quickly.

"It muſt be ſufficiently evident," ſays Dr Herſchel, "from what we have ſhown of the nature of openings, ſhallows, ridges, nodules, corrugations, indentations, and pores, that theſe phenomena could not appear, if the ſhining matter of the ſun were a liquid; ſince, by the laws of hydroſtatics, the openings, ſhallows, indentations, and pores, would inſtantly be filled up; nor could ridges and nodules preſerve their elevation for a ſingle moment. Whereas, many openings have been known to laſt for a whole revolution of the ſun; and extenſive elevations have remained ſupported for ſeveral days. Much leſs can it be an elaſtic fluid of an atmoſpheric nature: this would be ſtill more ready to fill up the low places, and to expand itſelf to a level at the top. It remains, therefore, only for us to admit this ſhining matter to exiſt in the manner of empyreal, luminous, or phoſphoric clouds, reſiding in the higher regions of the ſolar atmoſphere."

77 Two regions of ſolar clouds.

From his obſervations, Dr Herſchel concludes, that there are two different regions of ſolar clouds; that the inferior clouds are opaque, and probably not unlike thoſe of our planet; while the ſuperior are luminous, and emit a vaſt quantity of light: that the opaque inferior clouds probably ſuffer but little of the light of the ſelf-luminous ſuperior clouds to come to the body of the ſun. "The ſhallows about large openings," he obſerves, "are generally of ſuch a ſize, as hardly to permit any direct illumination from the ſuperior clouds to paſs over them into the openings; and the great height and cloſeneſs of the ſides of ſmall ones, though not often guarded by ſhallows, muſt alſo have nearly the ſame effect. By this it appears, that the planetary clouds are indeed a moſt effectual curtain, to keep the brightneſs of the ſuperior regions from the body of the ſun.

"Another advantage ariſing from the planetary clouds of the ſun, is of no leſs importance to the whole ſolar ſyſtem. Corrugations are everywhere diſperſed over the ſun; and their indentations may be called ſhallows in miniature. From this we may conclude, that the immenſe curtain of the planetary ſolar clouds is everywhere cloſely drawn; and, as our photometrical experiments have proved that theſe clouds reflect no leſs than 469 rays out of 1000, it is evident that they muſt add a moſt capital ſupport to the ſplendour of the ſun, by throwing back ſo great a ſhare of the brightneſs

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brightneſs coming to them from the illumination of the whole ſuperior regions."

Theſe obſervations are ſufficient to prove, that the ſun has an atmoſphere of great denſity, and extending to a great height. Like our atmoſphere, it is obviouſly ſubject to agitations, ſimilar to our winds; and it is alſo tranſparent. The following is Dr Herſchel's theoretical explanation of the ſolar phenomena.

78 Theory of the ſolar phenomena.

"We have admitted," ſays he, "that a tranſparent elaſtic gas comes up through the openings, by forcing itſelf a paſſage through the planetary clouds. Our obſervations ſeemed naturally to lead to this ſuppoſition, or rather to prove it; for, in tracing the ſhallows to their origin, it has been ſhewn, that they always begin from the openings, and go forwards. We have alſo ſeen, that in one caſe, a particular bias given to incipient ſhallows, lengthened a number of them out in one certain direction, which evidently denoted a propelling force acting the ſame way in them all. I am, however, well prepared to diſtinguiſh between facts obſerved, and the conſequences that in reaſoning upon them we may draw from them; and it will be eaſy to ſeparate them, if that ſhould hereafter be required.

"If, however, it be now allowed, that the cauſe we have aſſigned may be the true one, it will then appear, that the operations which are carried on in the atmoſphere of the ſun are very ſimple and uniform.

"By the nature and conſtruction of the ſun, an elaſtic gas, which may be called empyreal, is conſtantly formed. This aſcends everywhere, by a ſpecific gravity leſs than that of the general ſolar atmoſpheric gas contained in the lower regions. When it goes up in moderate quantities, it makes itſelf ſmall paſſages among the lower regions of clouds: theſe we have frequently obſerved, and have called them pores. We have ſhewn that they are liable to continual and quick changes, which muſt be a natural conſequence of their fleeting generation.

"When this empyreal gas has reached the higher regions of the ſun's atmoſphere, it mixes with other gaſes, which, from their ſpecific gravity, have their reſidence there, and occaſions decompoſitions which produce the appearance of corrugations. It has been ſhewn, that the elevated parts of the corrugations are ſmall ſelf-luminous nodules, or broken ridges; and I have uſed the name of ſelf-luminous clouds, as a general expreſſion for all phenomena of the ſun, in what ſhape ſoever they may appear, that ſhine by their own light. Theſe terms do not exactly convey the idea affixed to them; but thoſe of meteors, coruſcations, inflammations, luminous wiſps, or others, which I might have ſelected, would have been liable to ſtill greater objections. It is true, that when ſpeaking of clouds, we generally conceive ſomething too groſs, and even too permanent, to permit us to apply that expreſſion properly to luminous decompoſitions, which cannot float or ſwim in air, as we are uſed to ſee our planetary clouds do. But it ſhould be remembered, that, on account of the great compreſſion ariſing from the force of the gravity, all the elaſtic ſolar gaſes muſt be much condenſed; and that, conſequently, phenomena in the ſun's atmoſphere, which in ours would be mere tranſitory coruſcations, ſuch as thoſe of the aurora borealis, will be ſo compreſſed as to become much more efficacious and permanent.

"The great light occaſioned by the brilliant ſuperior regions, muſt ſcatter itſelf on the tops of the inferior planetary clouds, and, on account of their great denſity, bring on a very vivid reflection. Between the interſtices of the elevated parts of the corrugations, or ſelf-luminous clouds, which, according to the obſervations that have been given, are not cloſely connected, the light reflected from the lower clouds will be plainly viſible, and, being conſiderably leſs intenſe than the direct illumination from the upper regions, will occaſion that faint appearance which we have called indentations.

"This mixture of the light reflected from the indentations, and that which is emitted directly from the higher parts of the corrugations, unleſs very attentively examined by a ſuperior teleſcope, will only have the reſemblance of a mottled ſurface.

"When a quantity of empyreal gas, more than what produces only pores in aſcending, is formed, it will make itſelf ſmall openings; or, meeting perhaps with ſome reſiſtance in paſſing upwards, it may exert its action in the production of ridges and nodules.

"Laſtly, If ſtill further an uncommon quantity of this gas ſhould be formed, it will burſt through the planetary regions of clouds, and thus will produce great openings; then, ſpreading itſelf above them, it will occaſion large ſhallows, and, mixing afterwards gradually with other ſuperior gaſes, it will promote the increaſe, and aſſiſt in the maintenance, of the general luminous phenomena.

"If this account of the ſolar appearances ſhould be well founded, we ſhall have no difficulty in aſcertaining the actual ſtate of the ſun, with regard to its energy in giving light and heat to our globe; and nothing will now remain, but to decide the queſtion which will naturally occur, whether there be actually any conſiderable difference in the quantity of light and heat emitted from the ſun at different times." This queſtion he decides in the affirmative, conſidering the great number of ſpots as a proof that the ſun is emitting a great quantity of light and heat, and the want of ſpots as the contrary. The firſt is connected with a warm and good ſeaſon; the ſecond, on the contrary, produces a bad one *.

* *Phil. Tranſ.* 1801. part ii. p. 265.

Chap. II. *Of the Moon.*

Next to the ſun, the moſt conſpicuous of all the heavenly bodies is the moon. The changes which it undergoes are more ſtriking and more frequent than thoſe of the ſun, and its apparent motions much more rapid. Hence they were attended to even before thoſe of the ſun were known; a fact which explains why the firſt inhabitants of the earth reckoned their time by the moon's motions, and of courſe followed the lunar inſtead of the ſolar year. In conſidering the moon, we ſhall follow the ſame plan that we obſerved with reſpect to the ſun. We ſhall firſt give an account of her apparent motions; and, ſecondly, of her nature as far as it has been aſcertained. Theſe topics ſhall occupy the two following ſections.

Sect.

Sect. I. *Of the Apparent Motions of the Moon.*

The moon, like the ſun, has a peculiar motion from eaſt to weſt. If we obſerve her any evening when ſhe
79 Moon's motion in her orbit. is ſituated very near any fixed ſtar, we ſhall find her, in 24 hours, about 13° to the eaſt of that ſtar, and her diſtance continually increaſes, till at laſt, after a certain number of days, ſhe returns again to the ſame ſtar from the weſt, having performed a complete revolution in the heavens. By a continued ſeries of obſervations it has been aſcertained, that the moon makes a complete revolution in 27.32166118036 days, or 27 days 7 hours 43′ 11″ 31‴ 35⁗. Such at leaſt was the duration of its revolution at the commencement of 1700. But it does not remain always the ſame. From a compariſon between the obſervations of the ancients with thoſe of the moderns, it appears, that the mean motion of the moon in her orbit is accelerating. This acceleration, but juſt ſenſible at preſent, will gradually become more and more obvious. It is a point of great importance to diſcover, whether it will always continue to increaſe, or whether, after arriving at a certain maximum, it will again diminiſh. Obſervations could be of no ſervice for many ages in the reſolution of this queſtion; but the Newtonian theory has enabled aſtronomers to aſcertain that the acceleration is periodical.

The moon's motion in her orbit is ſtill more unequal than that of the ſun. In one part of her orbit ſhe moves faſter, in another ſlower. By knowing the time of a complete revolution, we can eaſily calculate the mean motion for a day, or any given time; and this mean motion is called the mean anomaly. The true motion is called the true anomaly: the difference between the two is called the equation. Now the moon's equation ſometimes amounts to 6° 18′ 32″.

Her apparent diameter varies with the velocity of her angular motion. When ſhe moves faſteſt, her diameter is largeſt; it is ſmalleſt when her angular mo-
80 Elliptical. tion is ſloweſt. When ſmalleſt, the apparent diameter is 0.489420°; when biggeſt, it is 0.558030°. Hence it follows, that the diſtance of the moon from the earth varies. By following the ſame mode of reaſoning, which we have detailed in the laſt chapter, Kepler aſcertained that the orbit of the moon is an ellipſe, having the earth in one of its foci. Her radius vector deſcribes equal areas in equal times; and her angular motion is inverſely proportional to the ſquare of her diſtance from the earth.

81 Its eccentricity. The eccentricity of the elliptic orbit of the moon, has been aſcertained to amount to 0.0550368, (the mean diſtance of the earth being repreſented by unity); or the greater axis is to the ſmaller, nearly as 100,000 to 99,848.

That point of the moon's orbit which is neareſt the earth, is called the *perigee;* the oppoſite point is the *apogee.* The line which joins theſe oppoſite points, is called the line of the moon's *apſides.* It moves ſlowly eaſtward, completing a ſidereal revolution in 3232.46643 days, or nearly 9 years.

82 Moon's irregularities. The inclination of the moon's orbit is alſo variable: the greateſt inequality is proportional to the coſine of twice the ſun's angular diſtance from the aſcending node, and amounts when a maximum to 0.14679°.

Even the elliptical orbit of the moon repreſents but imperfectly her real motion round the earth; for that luminary is ſubjected to a great number of irregularities, evidently connected with the poſitions of the ſun, which conſiderably alter the figure of her orbit. The three following are the principal of theſe. 83

1. The greateſt of all, and the one which was firſt The evection.
aſcertained, is called by aſtronomers the moon's *evection.* It is proportional to the ſine of twice the mean angular diſtance of the moon from the ſun, minus the mean angular diſtance of the moon from the perigee of its orbit. Its maximum amounts to 1.3410°. In the oppoſitions and conjunctions of the ſun and moon it coincides with the equation of the centre, which it always diminiſhes. Hence the ancients who determined that equation by means of the eclipſes, found that equation ſmaller than it is in reality. 84

2. There is another inequality in the motion of the Variation.
moon, which diſappears during the conjunctions and oppoſitions of the ſun and moon; and likewiſe when theſe bodies are 90° diſtant from each other. It is at its maximum when their mutual diſtance is about 45°, and then amounts to about 0.594°. Hence it has been concluded to be proportional to the ſine of twice the mean angular diſtance of the moon from the ſun. This inequality is called the *variation.* It diſappears during the eclipſes. 85

3. The moon's motion is accelerated when that of Annual equation.
the ſun is retarded, and the contrary. This occaſions an irregularity called the *annual equation.* It follows exactly the ſame law with that of the *equation of the centre* of the ſun, only with a contrary ſine. At its maximum it amounts to 0.18576°. During eclipſes, it coincides with the equation of the ſun.

The moon's orbit is inclined to the ecliptic at an angle of 5.14692°. The points where it interſects the ecliptic are called the *nodes.* Their poſition is not fixed in the heavens. They have a *retrograde* motion, that is to ſay, a motion contrary to that of the ſun. This motion may be eaſily traced by marking the ſucceſſive ſtars which the moon paſſes when ſhe croſſes the ecliptic. 86
They make a complete revolution of the Revolution of her nodes.
heavens in 6793.3009 days. The *aſcending* node is that in which the moon riſes above the ecliptic towards the north pole, the *deſcending* node that in which ſhe ſinks below the equator towards the ſouth pole. The motion of the nodes is ſubjected to ſeveral irregularities, the greateſt of which is proportional to the ſine of twice the angular diſtance of the ſun from the aſcending node of the lunar orbit. When at a maximum, it amounts to 1.62945°. The inclination of the orbit itſelf is variable. Its greateſt inequality amounts to 0.14679°. It is proportional to the coſine of the ſame angle on which the irregularity in the motion of the nodes depends.

The apparent diameter of the moon varies as well as that of the ſun, and in a more remarkable manner. When ſmalleſt, it meaſures 29.5′; when largeſt, 34′. This muſt be owing to the diſtance of the moon from the earth being ſubject to variations. 87

The great diſtance of the ſun from the earth ren- Moon's parallax.
ders it difficult to determine its parallax, on account of its minuteneſs. This is not the caſe with the moon. The diſtance of that luminary from the earth may be determined without much difficulty.

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Let BAG (fig. 10.) be one half of the earth, AC its ſemidiameter, S the ſun, *m* the moon, and EKOL a quarter of the circle deſcribed by the moon in revolving from the meridian to the meridian again. Let CRS be the rational horizon of an obſerver at A, extended to the ſun in the heavens; and HAO, his ſenſible horizon extended to the moon's orbit. ALC is the angle under which the earth's ſemidiameter AC is ſeen from the moon at L; which is equal to the angle OAL, becauſe the right lines AO and CL which include both theſe angles are parallel. ASC is the angle under which the earth's ſemidiameter AC is ſeen from the ſun at S: and is equal to the angle OA*f*, becauſe the lines AO and CRS are parallel. Now, it is found by obſervation, that the angle OAL is much greater than the angle OA*f*; but OAL is equal to ALC, and OA*f* is equal to ASC. Now as ASC is much leſs than ALC, it proves that the earth's ſemidiameter AC appears much greater as ſeen from the moon at L than from the ſun at S; and therefore the earth is much farther from the ſun than from the moon. The quantities of theſe angles may be determined by obſervation in the following manner.

Let a graduated inſtrument, as DAE (the larger the better), having a moveable index with ſight-holes, be fixed in ſuch a manner, that its plane ſurface may be parallel to the plane of the equator, and its edge AD in the meridian: ſo that when the moon is in the equinoctial, and on the meridian ADE, ſhe may be ſeen through the ſight-holes when the edge of the moveable index cuts the beginning of the diviſions at o, on the graduated limb DE; and when ſhe is ſo ſeen, let the preciſe time be noted. Now as the moon revolves about the earth from the meridian to the meridian again in about 24 hours 48 minutes, ſhe will go a fourth part round it in a fourth part of that time, viz. in 6 hours 12 minutes as ſeen from C, that is, from the earth's centre or pole. But as ſeen from A, the obſerver's place on the earth's ſurface, the moon will ſeem to have gone a quarter round the earth when ſhe comes to the ſenſible horizon at O; for the index through the ſights of which ſhe is then viewed will be at *d*, 90 degrees from D, where it was when ſhe was ſeen at E. Now let the exact moment when the moon is ſeen at O (which will be when ſhe is in or near the ſenſible horizon) be carefully noted (G) that it may be known in what time ſhe has gone from E to O; which time ſubtracted from 6 hours 12 minutes (the time of her going from E to L) leaves the time of her going from O to L, and affords an eaſy method for finding the angle OAL (called the *moon's horizontal parallax*, which is equal to the angle ALC) by the following analogy: As the time of the moon's deſcribing the arc EO is to 90 degrees, ſo is 6 hours 12 minutes to the degrees of the arc D*d*E, which meaſures the angle EAL; from which ſubtract 90 degrees, and there remains the angle OAL, equal to the angle ALC, under which the earth's ſemidiameter AC is ſeen from the moon. Now, ſince all the angles of a right-lined triangle are equal to 180 degrees, or to two right angles, and the ſides of a triangle are always proportional to the ſines of the oppoſite angles, ſay, by the Rule of Three, As the ſine of the angle ALC at the moon L, is to its oppoſite ſide AC, the earth's ſemidiameter, which is known to be 3985 miles; ſo is radius, viz. the ſine of 90 degrees, or of the right angle ACL, to its oppoſite ſide AL, which is the moon's diſtance at L from the obſerver's place at A on the earth's ſurface; or, ſo is the ſine of the angle CAL to its oppoſite ſide CL, which is the moon's diſtance from the earth's centre, and comes out at a mean rate to be 240,000 miles. The angle CAL is equal to what OAL wants of 90 degrees.

88 Another method.

Other methods have been fallen upon for determining the moon's parallax; of which the following is recommended as the beſt, by Mr Ferguſon, though hitherto it has not been put in practice. "Let two obſervers be placed under the ſame meridian, one in the northern hemiſphere and the other in the ſouthern, at ſuch a diſtance from each other, that the arc of the celeſtial meridian included between their two zeniths may be at leaſt 80 or 90 degrees. Let each obſerver take the diſtance of the moon's centre from his zenith, by means of an exceeding good inſtrument, at the moment of her paſſing the meridian: and theſe two zenith diſtances of the moon together, and their exceſs above the diſtance between the two zeniths, will be the diſtance between the two apparent places of the moon. Then, as the ſum of the natural ſines of the two zenith diſtances of the moon is to radius, ſo is the diſtance between her two apparent places to her horizontal parallax: which being found, her diſtance from the earth's centre may be found by the analogy mentioned above.

Thus, in fig. 11. let VECQ be the earth, M the moon, and *Zbaz* an arc of the celeſtial meridian. Let V be Vienna, whoſe latitude EV is 48° 20′ north; and C the Cape of Good Hope, whoſe latitude EC is 34° 30′ ſouth: both which latitudes we ſuppoſe to be accurately determined beforehand by the obſervers. As theſe two places are on the ſame meridian *n*VEC*s*, and in different hemiſpheres, the ſum of their latitudes 82° 50′ is their diſtance from each other. Z is the zenith of Vienna, and *z* the zenith of the Cape of Good Hope; which two zeniths are alſo 82° 50′ diſtant from each other, in the common celeſtial meridian Z*z*. To the obſerver at Vienna, the moon's centre will appear at *a* in the celeſtial meridian; and at the ſame inſtant, to the obſerver at the Cape, it will appear at *b*. Now ſuppoſe the moon's diſtance Z*a* from the zenith of Vienna to be 38° 1′ 53″, and her diſtance *zb* from the zenith of the Cape of Good Hope to be 46° 4′ 41″: the ſum of theſe two zenith diſtances (Z*a*+*zb*) is 84° 6′ 34″; from which ſubtract 82° 50′, the diſtance of Zz between the zeniths of theſe two places, and there will remain 1° 16′ 34″ for the arc *ba*, or diſtance between the two apparent places of the moon's centre, as ſeen from V and from C. Then, ſuppoſing

(G) Here proper allowance muſt be made for the refraction, which being about 34 minutes of a degree in the horizon, will cauſe the moon's centre to appear 34 minutes above the horizon when her centre is really in it.

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supposing the tabular radius to be 10,000,000, the natural sine of 38° 1′ 53″ (the arc Za) is 6,160,816, and the natural sine of 46° 4′ 41″ (the arc zb) is 7,202,821: the sum of both these sines is 13,363,637. Say therefore, As 13,363,637 is to 10,000,000, so is 1° 16′ 34″ to 57′ 18″, which is the moon's horizontal parallax.

If the two places of observation be not exactly under the same meridian, their difference of longitude must be accurately taken, that proper allowance may be made for the moon's declination whilst she is passing from the meridian of the one to the meridian of the other.

89 Moon's distance.

From the theory of the parallax we know, that at the distance of the moon from the earth the apparent size of the earth would be to that of the moon as 21.352 to 5823. Their respective diameters must be proportional to these numbers, or almost as 11 to 3. Hence the bulk of the moon is 49 times less than that of the earth.

90 Her phases explained.

The different appearances, or *phases*, of the moon constitute some of the most striking phenomena of the heavens. When she emerges from the rays of the sun in an evening, she appears after sunset as a small crescent just visible. The size of this crescent increases continually as she separates to a greater distance from the sun, and when she is exactly in opposition to that luminary, she appears under the form of a complete circle. This circle changes into a crescent as she approaches nearer that luminary, exactly in the same manner it had increased, till at last she disappears altogether, plunging into the sun's rays in the morning at sunrise. The crescent of the moon being always directed towards the sun, indicates obviously that she borrows her light from that luminary; while the law of the variation of her phases, almost proportional to the versed sine of the angular distance of the moon from the sun, demonstrates that her figure is spherical. Hence it follows, that the moon is an opaque spherical body.

These different phases of the moon are renewed after every conjunction. They depend upon the excess of the synodical movement of the moon above that of the sun, an excess which is usually termed the synodical motion of the moon. The duration of the synodical revolution of the moon in the mean period between two conjunctions is 29.530588 days. It is to the tropical year nearly in the ratio of 19 to 235, that is to say, that 19 solar years consist of about 235 lunar months.

The points of the lunar orbit, in which the moon is either in conjunction or opposition to the sun are called *syzigies*. In the first point the moon is said to be *new*, in the second to be *full*. The *quadratures* are those points in which the moon is distant from the sun 90° or 270°. When in these points the moon is said to be in her *first* and *third quarter*. One half only of the moon is then illuminated or seen from the earth. As a more particular account of these phases may be deemed necessary, we subjoin the following explanation, which will perhaps be better understood by the generality of readers.

91 Reflects the sun's light.

The moon is an opaque globe like the earth, and shines only by reflecting the light of the sun; therefore, whilst that half of her which is towards the sun is enlightened, the other half must be dark and invisible. Hence she disappears when she comes between us and the sun; because her dark side is then towards us. When she is gone a little way forward, we see a little of her enlightened side: which still increases to our view us she advances forward, until she comes to be opposite to the sun; and then her whole enlightened side is towards the earth, and she appears with a round illuminated orb, which we call the *full moon;* her dark side being then turned away from the earth. From the full she seems to decrease gradually as she goes through the other half of her course; showing us less and less of her enlightened side every day, till her next change or conjunction with the sun, and then she disappears as before.

The moon has scarce any difference of seasons; her axis being almost perpendicular to the ecliptic. What is very singular, one half of her has no darkness at all; the earth constantly affording it a strong light in the sun's absence; while the other half has a fortnight's darkness and a fortnight's light by turns.

Our earth is thought to be a moon to the moon; waxing and waning regularly, but appearing 13 times as big, and affording her 13 times as much light as she does us. When she changes to us the earth appears full to her; and when she is in her first quarter to us, the earth is in its third quarter to her; and *vice versa*. 92 Earth appears a moon to our moon.

But from one half of the moon the earth is never seen at all: from the middle of the other half, it is always seen over head; turning round almost 30 times as quick as the moon does. From the circle which limits our view of the moon, only one half of the earth's side next her is seen; the other half being hid below the horizon of all places on that circle. To her the earth seems to be the biggest body in the universe; for it appears 13 times as big as she does to us.

As the earth turns round its axis, the several continents, seas, and islands, appear to the moon's inhabitants like so many spots of different forms and brightness, moving over its surface; but much fainter at some times than others, as our clouds cover them or leave them. By these spots the lunarians can determine the time of the earth's diurnal motion, just as we do the motion of the sun: and perhaps they measure their time by the motion of the earth's spots; for they cannot have a truer dial.

The moon's axis is so nearly perpendicular to the ecliptic, that the sun never removes sensibly from her equator; and the obliquity of her orbit, which is next to nothing as seen from the sun, cannot cause the sun to decline sensibly from her equator. Yet her inhabitants are not destitute of means for ascertaining the length of their year, though their method and ours must differ. For we can know the length of our year by the return of our equinoxes; but the lunarians, having always equal day and night, must have recourse to another method; and we may suppose, they measure their year by observing when either of the poles of our earth begins to be enlightened, and the other to disappear, which is always at our equinoxes; they being conveniently situated for observing great tracts of land about our earth's poles which are entirely unknown to us. Hence we may conclude, that the year is of the same absolute length both to the earth and moon, though very 93 How the lunar inhabitants can measure their year.

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very different as to the number of days; we having $365\frac{1}{4}$ natural days, and the lunarians only $12\frac{1}{19}$, every day and night in the moon being as long as $29\frac{1}{2}$ on the earth.

The moon's inhabitants on the side next the earth may as easily find the longitude of their places as we can find the latitude of ours. For the earth keeping constantly, or very nearly so, over one meridian of the moon, the east or west distances of places from that meridian are as easily found as we can find our distance from the equator by the altitude of our celestial poles.

94 Longitude easily found.

As the sun can only enlighten that half of the earth which is at any moment turned towards him, and, being withdrawn from the opposite half, leaves it in darkness, so he likewise doth to the moon; only with this difference, that as the earth is surrounded by an atmosphere, we have twilight after the sun sets; but if the moon has none of her own, nor is included in that of the earth, the lunar inhabitants have an immediate transition from the brightest sunshine to the blackest darkness. (Fig. 12.) For, let t r k s w be the earth, and A, B. C, D, E, F, G, H, the moon in eight different parts of her orbit. As the earth turns round its axis from west to east, when any place comes to t, the twilight begins there, and when it revolves from thence to r the sun S rises; when the place comes to s the sun sets, and when it comes to w the twilight ends. But as the moon turns round her axis, which is only once a month, the moment that any part of her surface comes to *r* (see the moon at G), the sun rises there without any previous warning by twilight; and when the same point comes to *s* the sun sets, and that point goes into darkness as black as at midnight.

95 Her phases explained.

The moon being an opaque spherical body (for her hills take off no more from her roundness than the inequalities on the surface of an orange take off from its roundness), we can only see that part of the enlightened half of her which is towards the earth. And therefore, when the moon is at A, in conjunction with the sun S, her dark half is towards the earth, and she disappears, as at *a*, there being no light on that half to render it visible. When she comes to her first octant at B, or has gone an eighth part of her orbit from her conjunction, a quarter of her enlightened side is towards the earth, and she appears horned, as at *b*. When she has gone a quarter of her orbit from between the earth and sun to C, she shows us one half of her enlightened side, as at *c*, and we say, she is a quarter old. At D, she is in her second octant; and by showing us more of her enlightened side she appears gibbous, as at *d*. At E, her whole enlightened side is towards the earth; and therefore she appears round, as at *e*; when we say it is full moon. In her third octant at F, part of her dark side being towards the earth, she again appears gibbous, and is on the decrease, as at *f*. At G, we see just one half of her enlightened side; and she appears half decreased, or in her third quarter, as at *g*. At H, we only see a quarter of her enlightened side, being in her fourth octant; where she appears horned, as at *h*. And at A, having completed her course from the sun to the sun again, she disappears; and we say it is new moon. Thus, in going from A to E, the moon seems continually to increase; and in going from E to A, to decrease in the same proportion; having like phases at equal distances from A to E, but as seen from the sun S she is always full.

96 Never appears perfectly round.

The moon appears not perfectly round when she is full in the highest or lowest part of her orbit, because we have not a full view of her enlightened side at that time. When full in the highest part of her orbit, a small deficience appears on her lower edge; and the contrary when full in the lowest part of her orbit.

It is plain by the figure, that when the moon changes to the earth, the earth appears full to the moon; and *vice versa*. For when the moon is at A, new to the earth, the whole enlightened side of the earth is towards the moon; and when the moon is at E, full to the earth, its dark side is towards her. Hence a new moon answers to a full earth, and a full moon to a new earth. The quarters are also reversed to each other.

97 Agreeable representation of her phases.

Between the third quarter and change, the moon is frequently visible in the forenoon, even when the sun shines; and then she affords us an opportunity of seeing a very agreeable appearance, wherever we find a globular stone above the level of the eye, as suppose on the top of a gate. For, if the sun shines on the stone, and we place ourselves so as the upper part of the stone may just seem to touch the point of the moon's lowermost horn, we shall then see the enlightened part of the stone exactly of the same shape with the moon; horned as she is, and inclined the same way to the horizon. The reason is plain; for the sun enlightens the stone the same way as he does the moon: and both being globes, when we put ourselves into the above situation, the moon and stone have the same position to our eyes; and therefore we must see as much of the illuminated part of the one as of the other.

98 Nonagesimal degree.

The position of the moon's cusps, or a right line touching the points of her horns, is very differently inclined to the horizon at different hours of the same day of her age. Sometimes she stands, as it were, upright on her lower horn, and then such a line is perpendicular to the horizon: when this happens, she is in what the astronomers call *the nonagesimal degree*; which is the highest point of the ecliptic above the horizon at that time, and is 90° from both sides of the horizon where it is then cut by the ecliptic. But this never happens when the moon is on the meridian, except when she is at the very beginning of Cancer or Capricorn.

99 Eclipses of the moon.

The explanation of the phases of the moon leads us to that of the eclipses; those phenomena which formerly were the subjects of dread and error, but which philosophers have converted to the purposes of utility and instruction. The moon can only become eclipsed by the interposition of an opaque body, which intercepts from it the light of the sun; and it is obvious that this opaque body is the earth, because the eclipses of the moon never happen except when the moon is in opposition, and consequently when the earth is interposed between her and the sun. The globe of the earth projects behind it relatively to the motion of the sun a conical shadow, whose axis is the straight line that joins the centres of the earth and sun, and which terminates at the point when the apparent diameters of these two bodies become equal. The diameters of these bodies seen from the centre of the moon in opposition,

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ſition, are nearly in the proportion of 3 for the ſun and 11 for the earth. Therefore the conical ſhadow of the earth is at leaſt thrice as long as the diſtance between the earth and moon, and its breadth at the point where it is traverſed by the moon more than double the diameter of that luminary.

The moon, therefore, would be eclipſed every time that it is in oppoſition if the plane of its orbit coincided with the ecliptic. But in conſequence of the mutual inclination of theſe two planes the moon, when in oppoſition, is often elevated above the earth's conical ſhadow, or depreſſed below it; and never can paſs through that ſhadow unleſs when it is near the nodes. If the whole of the moon's diſk plunges into the ſhadow, the eclipſe is ſaid to be *total;* if only a part of the diſk enter the ſhadow, the eclipſe is ſaid to be *partial.*

100 Period of the eclipſes.

The mean duration of a revolution of the ſun relatively to the nodes of the lunar orbit is 346.61963 days, and is to the duration of a ſynodical revolution of the moon nearly as 223 to 19. Conſequently, after a period of 223 lunar months, the ſun and moon return nearly to the ſame ſituation relatively to the order of the lunar orbit. Of courſe the eclipſes muſt return in the ſame order after every 223 lunations. This gives us an eaſy method of predicting them. But the inequalities in the motions of the ſun and moon occaſion ſenſible differences; beſides the return of the two luminaries to the ſame points relatively to the nodes not being rigorouſly true, the deviations occaſioned by this want of exactneſs alter at laſt the order of the eclipſes obſerved during one of theſe periods.

The following explanation of the lunar eclipſes being more particular, may be acceptable to ſome of our readers.

That the moon can never be eclipſed but at the time of her being full, and the reaſon why ſhe is not eclipſed at every full, has been ſhown already. In fig. 13. let S be the ſun, E the earth, RR the earth's ſhadow, and B the moon in oppoſition to the ſun: In this ſituation the earth intercepts the ſun's light in its way to the moon; and when the moon touches the earth's ſhadow at *v*, ſhe begins to be eclipſed on her eaſtern limb *x*, and continues eclipſed until her weſtern limb *y* leaves the ſhadow at *w*: at B ſhe is in the middle of the ſhadow, and conſequently in the middle of the eclipſe.

101 Why the moon is viſible when eclipſed.

The moon, when totally eclipſed, is not inviſible if ſhe be above the horizon and the ſky be clear; but appears generally of a duſky colour, like tarniſhed copper, which ſome have thought to be the moon's native light. But the true cauſe of her being viſible is the ſcattered beams of the ſun, bent into the earth's ſhadow by going through the atmoſphere; which, being more or leſs denſe near the earth than at conſiderable heights above it, refracts or bends the ſun's rays more inward, the nearer they are paſſing by the earth's ſurface, than thoſe rays which go through higher parts of the atmoſphere, where it is leſs denſe according to its height, until it be ſo thin or rare as to loſe its refractive power. Let the circle *f*, *g*, *h*, *i*, concentric to the earth, include the atmoſphere whoſe refractive power vaniſhes at the heights *f* and *i*; ſo that the rays W*fw* and V*iv* go on ſtraight without ſuffering the leaſt refraction: but all thoſe rays which enter the atmoſphere between *f* and *k*, and between *i* and *l*, on oppoſite ſides of the earth, are gradually more bent inward as they go through a greater portion of the atmoſphere, until the rays W*k* and V*l* touching the earth at *m* and *n*, are bent ſo much as to meet at *q*, a little ſhort of the moon; and therefore the dark ſhadow of the earth is contained in the ſpace *mopqn*, where none of the ſun's rays can enter; all the reſt R, R, being mixed by the ſcattered rays which are refracted as above, is in ſome meaſure enlightened by them; and ſome of thoſe rays falling on the moon, give her the colour of tarniſhed copper or of iron almoſt red hot. So that if the earth had no atmoſphere, the moon would be as inviſible in total eclipſes as ſhe is when new. If the moon were ſo near the earth as to go into its dark ſhadow, ſuppoſe about *po*, ſhe would be inviſible during her ſtay in it; but viſible before and after in the fainter ſhadow RR.

When the moon goes through the centre of the earth's ſhadow ſhe is directly oppoſite to the ſun; yet the moon has been often ſeen totally eclipſed in the horizon when the ſun was alſo viſible in the oppoſite part of it; for the horizontal refraction being almoſt 34 minutes of a degree, and the diameter of the ſun and moon being each at a mean ſtate but 32 minutes, the refraction cauſes both luminaries to appear above the horizon when they are really below it.

When the moon is full at 12 degrees from either of her nodes, ſhe juſt touches the earth's ſhadow, but enters not into it. In fig. 14. let GH be the ecliptic, *ef* the moon's orbit where ſhe is 12 degrees from the node at her full, *cd* her orbit where ſhe is 6 degrees from the node, *ab* her orbit where ſhe is full in the node, AB the earth's ſhadow, and M the moon. When the moon deſcribes the line *ef*, ſhe juſt touches the ſhadow, but does not enter into it; when ſhe deſcribes the line *cd*, ſhe is totally, though not centrally, immerſed in the ſhadow; and when ſhe deſcribes the line *ab*, ſhe paſſes by the node at M in the centre of the ſhadow, and takes the longeſt line poſſible, which is a diameter, through it: and ſuch an eclipſe being both total and central, is of the longeſt duration, namely, 3 h. 57 m. 6 ſec. from the beginning to the end, if the moon be at her greateſt diſtance from the earth; and 3 h. 37 m. 26 ſec. if ſhe be at her leaſt diſtance. The reaſon of this difference is, that when the moon is fartheſt from the earth, ſhe moves ſloweſt; and when neareſt to it, quickeſt.

The moon's diameter, as well as the ſun's, is ſuppoſed to be divided into 12 equal parts, called *digits;* and ſo many of theſe parts as are darkened by the earth's ſhadow, ſo many digits is the moon eclipſed. All that the moon is eclipſed above 12 digits, ſhows how far the ſhadow of the earth is over the body of the moon, on that edge to which ſhe is neareſt at the middle of the eclipſe.

102 Lunar eclipſes difficultly obſerved.

It is difficult to obſerve exactly either the beginning or ending of a lunar eclipſe, even with a good teleſcope, becauſe the earth's ſhadow is ſo faint and ill-defined about the edges, that when the moon is either juſt touching or leaving it, the obſcuration of her limb is ſcarce ſenſible; end therefore the niceſt obſervers can hardly be certain to four or five ſeconds of time. But both

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both the beginning and ending of solar eclipſes are viſibly inſtantaneous: for the moment that the edge of the moon's diſk touches the ſun's, his roundneſs ſeems a little broke on that part; and the moment ſhe leaves it, he appears perfectly round again.

103 Eclipſes of the ſun.

The eclipſes of the ſun only take place during the conjunctions of the ſun and moon, or when the moon is placed between the ſun and the earth. They are owing to the moon concealing the ſun from the earth, or to the earth being plunged in the ſhadow of the moon. The moon is indeed much ſmaller than the ſun; but it is ſo much nearer to the earth that its apparent diameter does not differ much from the diameter of that luminary: and, in conſequence of the changes which take place in the apparent diameters of theſe bodies, it happens that ſometimes the apparent diameter of the moon is greater than that of the ſun. If we ſuppoſe the centres of the ſun and moon in the ſame ſtraight line with the eye of a ſpectator placed on the earth, he will ſee the ſun eclipſed. If the apparent diameter of the moon happens to ſurpaſs that of the ſun, the eclipſe will be *total:* but if the moon's diameter be ſmalleſt, the obſerver will ſee a luminous ring, formed by that part of the ſun's diſk which exceeds that of the moon's, and the eclipſe will in that caſe be *annular.* If the centre of the moon is not in the ſame ſtraight line which joins the obſerver and the centre of the ſun, the eclipſe can only be *partial*, as the moon can only conceal a *part* of the ſun's diſk. Hence there muſt be a great variety in the appearance of the ſolar eclipſes. We may add alſo to theſe cauſes of variety the elevation of the moon above the horizon, which changes its apparent diameter conſiderably. For it is well known, that the moon's diameter appears larger when ſhe is near the horizon than when ſhe is elevated far above it. Now, as the moon's height above the horizon varies according to the longitude of the obſerver, it follows, that the ſolar eclipſes will not have the ſame appearance to the obſervers ſituated in different longitudes. One obſerver may ſee an eclipſe which does not happen relatively to another. In this reſpect the ſolar differ from the lunar eclipſes, which are the ſame to all the inhabitants of the earth.

104 Number of eclipſes in a year.

In any year, the number of eclipſes of both luminaries cannot be leſs than two, nor more than ſeven; the moſt uſual number is four, and it is very rare to have more than ſix. For the ſun paſſes by both the nodes but once a-year, unleſs he paſſes by one of them in the beginning of the year; and, if he does, he will paſs by the ſame node again a little before the year be finiſhed; becauſe, as theſe points move 19¼ degrees backwards every year, the ſun will come to either of them 173 days after the other. And when either node is within 17 degrees of the ſun at the time of new moon, the ſun will be eclipſed. At the ſubſequent oppoſition, the moon will be eclipſed in the other node, and come round to the next conjunction again ere the former node be 17 degrees paſt the ſun, and will therefore eclipſe him again. When three eclipſes fall about either node, the like number generally falls about the oppoſite; as the ſun comes to it in 173 days afterwards; and ſix lunations contain but four days more. Thus, there may be two eclipſes of the ſun and one of the moon about each of her nodes. But when the moon changes in either of the nodes, ſhe cannot be near enough the other node at the next full to be eclipſed; and in ſix lunar months afterward ſhe will change near the other node: in theſe caſes, there can be but two eclipſes in a year, and they are both of the ſun.

A longer period than the above-mentioned, for comparing and examining eclipſes which happen at long intervals of time, is 557 years, 21 days, 18 hours, 30 minutes, 11 ſeconds; in which time there are 6890 mean lunations; and the ſun and node meet again ſo nearly as to be but 11 ſeconds diſtant; but then it is not the ſame eclipſe that returns, as in the ſhorter period above mentioned.

Eclipſes of the ſun are more frequent than of the moon, becauſe the ſun's ecliptic limits are greater than the moon's; yet we have more viſible eclipſes of the moon than of the ſun, becauſe eclipſes of the moon are ſeen from all parts of that hemiſphere of the earth which is next her, and are equally great to each of thoſe parts: but the ſun's eclipſes are viſible only to that ſmall portion of the hemiſphere next him whereon the moon's ſhadow falls. 105 Why more eclipſes of the moon than of the ſun are obſerved.

The moon's orbit being elliptical, and the earth in one of its focuſes, ſhe is once at her leaſt diſtance from the earth, and once at her greateſt, in every lunation. When the moon changes at her leaſt diſtance from the earth, and ſo near the node that her dark ſhadow falls upon the earth, ſhe appears big enough to cover the whole diſk of the ſun from that part on which her ſhadow falls; and the ſun appears totally eclipſed there for ſome minutes: but when the moon changes at her greateſt diſtance from the earth, and ſo near the node that her dark ſhadow is directed towards the earth, her diameter ſubtends a leſs angle than the ſun's; and therefore ſhe cannot hide his whole diſk from any part of the earth, nor does her ſhadow reach it at that time; and to the place over which the point of her ſhadow hangs, the eclipſe is annular, the ſun's edge appearing like a luminous ring all round the body of the moon. 106 Total and annular eclipſes.

When the change happens within 17 degrees of the node, and the moon at her mean diſtance from the earth, the point of her ſhadow juſt touches the earth, and ſhe eclipſeth the ſun totally to that ſmall ſpot whereon her ſhadow falls; but the darkneſs is not of a moment's continuance.

The moon's apparent diameter, when largeſt, exceeds the ſun's, when leaſt, only 1 minute 38 ſeconds of a degree; and in the greateſt eclipſe of the ſun that can happen at any time and place, the total darkneſs continues no longer than whilſt the moon is going 1 minute 38 ſeconds from the ſun in her orbit, which is about 3 minutes and 13 ſeconds of an hour.

The moon's dark ſhadow covers only a ſpot on the earth's ſurface about 180 Engliſh miles broad, when the moon's diameter appears largeſt, and the ſun's leaſt; and the total darkneſs can extend no farther than the dark ſhadow covers. Yet the moon's partial ſhadow or penumbra may then cover a circular ſpace 4900 miles in diameter, within all which the ſun is more or leſs eclipſed, as the places are leſs or more diſtant from the centre of the penumbra. When the moon changes exactly 107 Extent of the moon's ſhadow and penumbra.

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exactly in the node, the penumbra is circular on the earth at the middle of the general eclipse; because at that time it falls perpendicularly on the earth's surface; but at every other moment it falls obliquely, and will therefore be elliptical; and the more so, as the time is longer before or after the middle of the general eclipse; and then much greater portions of the earth's surface are involved in the penumbra.

108 Beginning, ending, &c. of a solar eclipse.

When the penumbra first touches the earth, the general eclipse begins; when it leaves the earth, the general eclipse ends: from the beginning to the end the sun appears eclipsed in some part of the earth or other. When the penumbra touches any place, the eclipse begins at that place, and ends when the penumbra leaves it. When the moon changes in the node, the penumbra goes over the centre of the earth's disk as seen from the moon; and consequently, by describing the longest line possible on the earth, continues the longest upon it; namely, at a mean rate, 5 hours 50 minutes; more, if the moon be at her greatest distance from the earth, because she then moves slowest; less, if she be at her least distance, because of her quicker motion.

Fig. 13.

To make several of the above and other phenomena plainer, let S be the sun, E the earth, M the moon, and AMP the moon's orbit. Draw the right line W*e* from the western side of the sun at W, touching the western side of the moon at *c*, and the earth at *e*: draw also the right line V*d* from the eastern side of the sun at V, touching the eastern side of the moon at *d*, and the earth at *e*: the disk space *ced* included between those lines is the moon's shadow, ending in a point at *e*, where it touches the earth; because in this case the moon is supposed to change at M in the middle between A the apogee, or farthest point of her orbit from the earth, and P the perigee, or nearest point to it. For, had the point P been at M, the moon had been nearer the earth; and her dark shadow at *e* would have covered a space upon it about 180 miles broad, and the sun would have been totally darkened, with some continuance: but had the point A been at M, the moon would have been farther from the earth, and her shadow would have ended in a point a little above *e*, and therefore the sun would have appeared like a luminous ring all around the moon. Draw the right lines WX*db* and VX*cg*, touching the contrary sides of the sun and moon, and ending on the earth at *a* and *b*; draw also the right line SXM, from the centre of the sun's disk, through the moon's centre, to the earth; and suppose the two former lines WX*db* and VX*cg* to revolve on the line SXM as an axis, and their points *a* and *b* will describe the limits of the penumbra TT on the earth's surface, including the large space *aba*; within which the sun appears more or less eclipsed, as the places are more or less distant from the verge of the penumbra *ab*.

Draw the right line *y* 12 across the sun's disk, perpendicular to SXM the axis of the penumbra; then divide the line *y* 12 into twelve equal parts, as in the figure, for the twelve digits or equal parts of the sun's diameter; and at equal distances from the centre of the penumbra at *e* (on the earth's surface YY) to its edge *ab*, draw twelve concentric circles, marked with the numeral figures 1 2 3 4, &c. and remember that the moon's motion in her orbit AMP is from west to east, as from *s* to *t*. Then,

To an observer on the earth at *b*, the eastern limb of the moon at *d* seems to touch the western limb of the sun at W, when the moon is at M; and the sun's eclipse begins at *b*, appearing as at A, fig. 15. at the left hand; but at the same moment of absolute time, to an observer at *a* in fig. 14. the western edge of the moon at *c* leaves the eastern edge of the sun at V, and the eclipse ends, as at the right hand C, fig. 15. At the very same instant, to all those who live on the circle marked 1 on the earth A, in fig. 14. the moon M cuts off or darkens a twelfth part of the sun S, and eclipses him one digit, as at 1 in fig. 15.: to those who live on the circle marked 2 in fig. 14. the moon cuts off two twelfth parts of the sun, as at 2 in fig. 15: to those on the circle 3, three parts; and so on to the centre at 12 in fig. 14. where the sun is centrally eclipsed, as at B in the middle of fig. 15.; under which figure there is a scale of hours and minutes, to show at a mean state how long it is from the beginning to the end of a central eclipse of the sun on the parallel of London; and how many digits are eclipsed at any particular time from the beginning at A to the middle at B, or the end at C. Thus, in 16 minutes from the beginning, the sun is two digits eclipsed; in an hour and five minutes, eight digits; and in an hour and 37 minutes, 12 digits.

By fig. 14. it is plain, that the sun is totally or centrally eclipsed but to a small part of the earth at any time, because the dark conical shadow *e* of the moon M falls but on a small part of the earth; and that the partial eclipse is confined at that time to the space included by the circle *ab*, of which only one half can be projected in the figure, the other half being supposed to be hid by the convexity of the earth E; and likewise, that no part of the sun is eclipsed to the large space YY of the earth, because the moon is not between the sun and any of that part of the earth; and therefore to all that part the eclipse is invisible. The earth turns eastward on its axis, as from *g* to *h*, which is the same way that the moon's shadow moves; but the moon's motion is much swifter in her orbit from *s* to *t*: and therefore, although eclipses of the sun are of no longer duration on account of the earth's motion on its axis than they would be if that motion was stopped, yet in four minutes of time at most, the moon's swifter motion carries her dark shadow quite over any place that its centre touches at the time of greatest obscuration. The motion of the shadow on the earth's disk is equal to the moon's motion from the sun, which is about $30\frac{1}{2}$ minutes of a degree every hour at a mean rate; but so much of the moon's orbit is equal to $30\frac{1}{2}$ degrees of a great circle on the earth; and therefore the moon's shadow goes $30\frac{1}{2}$ degrees, or 1830 geographical miles on the earth in an hour, or $30\frac{1}{2}$ miles in a minute, which is almost four times as swift as the motion of a cannon-ball.

As seen from the sun or moon, the earth's axis appears differently inclined every day of the year, on account of keeping its parallelism throughout its annual course. In fig. 16. let EDON be the earth at the two equinoxes and the two solstices, NS its axis, N the north pole, S the south pole, ÆQ the equator,

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T the tropic of Cancer, *t* the tropic of Capricorn, and ABC the circumference of the earth's enlightened disk as seen from the sun or new moon at these times. The earth's axis has the position NES at the vernal equinox, lying towards the right hand, as seen from the sun or new moon; its poles N and S being then in the circumference of the disk; and the equator and all its parallels seem to be straight lines, because their planes pass through the observer's eye looking down upon the earth from the sun or moon directly over E, where the ecliptic FG intersects the equator Æ. At the summer solstice the earth's axis has the position NDS; and that part of the ecliptic FG, in which the moon is then new, touches the tropic of Cancer T at D. The north pole N at that time inclining $23\frac{1}{2}$ degrees towards the sun, falls so many degrees within the earth's enlightened disk, because the sun is then vertical to D $23\frac{1}{2}$ degrees north of the equator or ÆQ; and the equator, with all its parallels seem elliptic curves bending downward, or towards the south pole, as seen from the sun; which pole, together with $23\frac{1}{2}$ degrees all round it, is hid behind the disk in the dark hemisphere of the earth. At the autumnal equinox, the earth's axis has the position NOS, lying to the left hand as seen from the sun or new moon, which are then vertical to O, where the ecliptic cuts the equator ÆQ. Both poles now lie in the circumference of the disk, the north pole just going to disappear behind it, and the south pole just entering into it; and the equator with all its parallels seem to be straight lines, because their planes pass through the observer's eye, as seen from the sun, and very nearly so as seen from the moon. At the winter solstice, the earth's axis has the position NNS when its south pole S inclining $23\frac{1}{2}$ degrees towards the sun, falls $23\frac{1}{2}$ degrees within the enlightened disk, as seen from the sun or new moon, which are then vertical to the tropic of Capricorn *t*, $23\frac{1}{2}$ degrees south of the equator ÆQ; and the equator, with all its parallels, seem elliptic curves bending upward; the north pole being as far hid behind the disk in the dark hemisphere as the south pole is come into the light. The nearer that any time of the year is to the equinoxes or solstices, the more it partakes of the phenomena relating to them.

Thus it appears, that from the vernal equinox to the autumnal, the north pole is enlightened: and the equator and all its parallels appear elliptical as seen from the sun, more or less curved as the time is nearer to, or farther from, the summer solstice; and bending downwards, or towards the south pole; the reverse of which happens from the autumnal equinox to the vernal. A little consideration will be sufficient to convince the reader, that the earth's axis inclines towards the sun at the summer solstice; from the sun at the winter solstice; and sidewise to the sun at the equinoxes: but towards the right hand, as seen from the sun at the vernal equinox; and towards the left hand at the autumnal. From the winter to the summer solstice, the earth's axis inclines more or less to the right hand, as seen from the sun; and the contrary from the summer to the winter solstice.

The different positions of the earth's axis, as seen from the sun at different times of the year, affect solar eclipses greatly with regard to particular places; yea, so far as would make central eclipses which fall at one time of the year invisible if they fell at another, even though the moon should always change in the nodes, and at the same hour of the day; of which indefinitely various affections, we shall only give examples for the times of the equinoxes and solstices.

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109 Eclipses affected by the position of the earth's axis.

In the same diagram, let FG be part of the ecliptic, and IK, *ik*, *ik*, *ik*, part of the moon's orbit; both seen edgewise, and therefore projected into right lines; and let the intersections NODE be one and the same node at the above times, when the earth has the forementioned different positions; and let the spaces included by the circles P*ppp* be the penumbra at these times, as its centre is passing over the centre of the earth's disk. At the winter solstice, when the earth's axis has the position NNS, the centre of the penumbra P touches the tropic of Capricorn *t* in N at the middle of the general eclipse; but no part of the penumbra touches the tropic of Cancer T. At the summer solstice, when the earth's axis has the position NDS (*i* D *k* being then part of the moon's orbit whose node is at D), the penumbra *p* has its centre at D, on the tropic of Cancer T, at the middle of the general eclipse, and then no part of it touches the tropic of Capricorn *t*. At the autumnal equinox, the earth's axis has the position NOS (*i* O *k* being then part of the moon's orbit), and the penumbra equally includes part of both tropics T and *t*, at the middle of the general eclipse: at the vernal equinox it does the same, because the earth's axis has the position NES; but, in the former of these two last cases, the penumbra enters the earth at A, north of the tropic of Cancer T, and leaves it at *m* south of the tropic of Capricorn *t*; having gone over the earth obliquely southward, as its centre described the line AO*m*: whereas, in the latter case, the penumbra touches the earth at *n*, south of the equator ÆQ, and describing the line *n*E*q* (similar to the former line AO*m* in open space), goes obliquely northward over the earth, and leaves it at *q*, north of the equator.

In all these circumstances the moon has been supposed to change at noon in her descending node: Had she changed in her ascending node, the phenomena would have been as various the contrary way, with respect to the penumbra's going northward or southward over the earth. But because the moon changes at all hours, as often in one node as in the other, and at all distances from them both at different times as it happens, the variety of the phases of eclipses are almost innumerable, even at the same places; considering also how variously the same places are situated on the enlightened disk of the earth, with respect to the penumbra's motion, at the different hours when eclipses happen.

When the moon changes 17 degrees short of her descending node, the penumbra P18 just touches the northern part of the earth's disk, near the north pole N; and as seen from that place, the moon appears to touch the sun, but hides no part of him from sight. Had the change been as far short of the ascending node, the penumbra would have touched the southern part of the disk near the south pole S. When the moon changes 12 degrees short of the descending node, more than a third part of the penumbra P12 falls on the northern parts of the earth at the middle of the general eclipse: Had she changed as far past the same node, as

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as much of the other side of the penumbra about P would have fallen on the southern parts of the earth; all the rest in the expansum, or open space. When the moon changes 6 degrees from the node, almost the whole penumbra P6 falls on the earth at the middle of the general eclipse. And lastly, when the moon changes in the node at N, the penumbra PN takes the longest course possible on the earth's disk; its centre falling on the middle thereof, at the middle of the general eclipse. The farther the moon changes from either node, within 17 degrees of it, the shorter is the penumbra's continuance on the earth, because it goes over a less portion of the disk, as is evident by the figure.

110 Duration of eclipses in different parts of the earth.

The nearer that the penumbra's centre is to the equator at the middle of the general eclipse, the longer is the duration of the eclipse at all those places where it is central; because, the nearer that any place is to the equator, the greater is the circle it describes by the earth's motion on its axis: and so, the place moving quicker, keeps longer in the penumbra, whose motion is the same way with that of the place, though faster, as has been already mentioned. Thus (see the earth at D and the penumbra at 12) whilst the point *b* in the polar circle *a b c d* is carried from *b* to *c* by the earth's diurnal motion, the point *d* on the tropic of Cancer T is carried a much greater length from *d* to D; and therefore, if the penumbra's centre goes one time over *c* and another time over D, the penumbra will be longer in passing over the moving place *d* than it was in passing over the moving place *b*. Consequently, central eclipses about the poles are of the shortest duration; and about the equator, of the longest.

In the middle of summer, the whole frigid zone, included by the polar circle *abcd*, is enlightened: and if it then happens that the penumbra's centre goes over the north pole, the sun will be eclipsed much the same number of digits at *a* as at *c*; but whilst the penumbra moves eastward over *c*, it moves eastward over *a*; because, with respect to the penumbra, the motions of *a* and *c* are contrary: for *c* moves the same way with the penumbra towards *d*, but *a* moves the contrary way towards *b*; and therefore the eclipse will be of longer duration at *c* than at *a*. At *a* the eclipse begins on the sun's eastern limb, but at *c* on his western: at all places lying without the polar circles, the sun's eclipses begin on his western limb, or near it, and end on or near his eastern. At those places where the penumbra touches the earth, the eclipse begins with the rising sun, on the top of his western or uppermost edge; and at those places where the penumbra leaves the earth, the eclipse ends with the setting sun, on the top of his eastern edge, which is then the uppermost, just at its disappearing in the horizon.

About the new moon, that part of the lunar disk which is not illuminated by the sun is perceptible, owing to the feeble light reflected on it by the hemisphere of the earth that is illuminated.

Sect. II. *Of the Nature of the Moon.*

111 Moon's size.

We have seen that the moon is about 39 times smaller than the earth. Her diameter is generally reckoned about 2180 miles. This is to the diameter of the earth nearly as 20 to 73; therefore, the surface of the moon is to that of the earth (being as the squares of their diameters) nearly as 1 to 14 $\frac{1}{3}$. And, admitting the moon's density to be to that of the earth as 5 to 4, their respective quantities of matter will be as 1 to 39 very nearly.

Bouguer has shown by a set of curious experiments that the light emitted by the full moon is 300,000 times less intense than that of the sun. Even when concentrated by the most powerful mirrors it produces no effect on the thermometer. 112 Light.

Many duskish spots may be seen upon the moon's disk, even with the naked eye; and through a telescope, their number is prodigiously increased: she also appears very plainly to be more protuberant in the middle than at the edges, or to have the figure of a globe and not a flat circle. When the moon is horned or gibbous, the one side appears very ragged and uneven, but the other always exactly defined and circular. The spots in the moon always keep their places exactly; never vanishing, or going from one side to the other, as those of the sun do. We sometimes see more or less of the northern and southern, and eastern and western part of the disk or face; but this is owing to what is called her libration, and will hereafter be explained. 113 Spots on her surface.

The astronomers Florentius, Langrenus, John Hevelius of Dantzic, Grimaldus, Ricciolus, Cassini, and M. de la Hire, have drawn the face of the moon as she is seen through telescopes magnifying between 200 and 300 times. Particular care has been taken to note all the shining parts in her surface; and, for the better distinguishing them, each has been marked with a proper name. Langrenus and Ricciolus have divided the lunar regions among the philosophers, astronomers, and other eminent men; but Hevelius and others, fearing lest the philosophers should quarrel about the division of their lands, have endeavoured to spoil them of their property, by giving the names belonging to different countries, islands, and seas on earth, to different parts of the moon's surface, without regard to situation or figure. The names adopted by Ricciolus, however, are those which are generally followed, as the names of *Hipparchus*, *Tycho*, *Copernicus*, &c. are more pleasing to astronomers than those of Africa, the Mediterranean Sea, Sicily, and Mount Ætna. Fig. 17. is a tolerably exact representation of the full moon in her mean libration, with the numbers to the principal spots according to Ricciolus, Cassini, Mayer, &c. The asterisk refers to one of the volcanoes discovered by Dr Herschel, to be afterwards more particularly noticed. The names are as follows:

* Herschel's Volcano.	16 Timocharis.
1 Grimaldus.	17 Plato.
2 Galilæus.	18 Archimedes.
3 Aristarchus.	19 Insula Sinus Medii.
4 Keplerus.	20 Pitatus.
5 Gassendus.	21 Tycho.
6 Shikardus.	22 Eudoxus.
7 Harpalus.	23 Aristoteles.
8 Heraclides.	24 Manilius.
9 Lansbergius.	25 Menelaus.
10 Reinoldus.	26 Hermes.
11 Copernicus.	27 Possidonius.
12 Helicon.	28 Dionysius.
13 Capuanus.	29 Plinius.
14 Bullialdus.	30 { Casharina Cyrillus. Theophilus.
15 Eratosthenes.	31 Fracastorius.

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31	Fracaſtorius.	40	Taruntius.
32	Promontorium acutum Cenſorinus.	*A*	Mare Humorum.
33	Meſala.	*B*	Mare Nubium
34	Promontorium Somnii.	*C*	Mare Imbrium.
35	Proclus.	*D*	Mare Nectaris.
36	Cleomedes.	*E*	Mare Tranquillitatis.
37	Snellius et Furnerius.	*F*	Mare Serenitatis.
38	Petavius.	*G*	Mare Fœcunditatis.
39	Langrenus.	*H*	Mare Criſium.

114 Great inequalities on the ſurface of the moon.

That there are prodigious inequalities on her ſurface, is proved by looking at her through a teleſcope, at any other time than when ſhe is full; for then there is no regular line bounding light and darkneſs: but the confines of theſe parts appear as it were toothed and cut with innumerable notches and breaks: and even in the dark part, near the borders of the lucid ſurface, there are ſeen ſome ſmall ſpaces enlightened by the ſun's beams. Upon the fourth day after new moon, there may be perceived ſome ſhining points like rocks or ſmall iſlands within the dark body of the moon; but not far from the confines of light and darkneſs there are obſerved other little ſpaces which join to the enlightened ſurface, but run out into the dark ſide, which by degrees change their figure, till at laſt they come wholly within the illuminated face, and have no dark parts round them at all. Afterwards many more ſhining ſpaces are obſerved to ariſe by degrees, and to appear within the dark ſide of the moon, which before they drew near to the confines of light and darkneſs were inviſible, being without any light, and totally immerſed in the ſhadow. The contrary is obſerved in the decreaſing phaſes, where the lucid ſpaces which joined the illuminated ſurface by degrees recede from it, and, after they are quite ſeparated from the confines of light and darkneſs, remain for ſome time viſible, till at laſt they alſo diſappear. Now it is impoſſible that this ſhould be the caſe, unleſs theſe ſhining points were higher than the reſt of the ſurface, ſo that the light of the ſun may reach them.

115 Method of meaſuring the lunar mountains. Fig. 20.

Not content with perceiving the bare exiſtence of theſe lunar mountains, aſtronomers have endeavoured to meaſure their height in the following manner. Let EGD be the hemiſphere of the moon illuminated by the ſun, ECD the diameter of the circle bounding light and darkneſs, and A the top of a hill within the dark part when it firſt begins to be illuminated. Obſerve with a teleſcope the proportion of the right line AE, or the diſtance of the point A from the lucid ſurface to the diameter of the moon ED; and becauſe in this caſe the ray of light ES touches the globe of the moon, AEC will be a right angle by 16th prop. of Euclid's third book; and therefore in the triangle AEC having the two ſides AE and EC, we can find out the third ſide AC; from which ſubducting BC or EC, there will remain AB the height of the mountain. Ricciolus affirms, that upon the fourth day after new moon he has obſerved the top of the hill called *St Catharine's* to be illuminated, and that it was diſtant from the confines of the lucid ſurface about a ſixteenth part of the moon's diameter. Therefore, if CF=8, AE will be 1, and $AC^2=CE^2+AE^2$ by prop. 47. of Euclid's firſt book. Now, the ſquare of CE being 64, and the ſquare of AE being 1, the ſquare of AC will be 65, whoſe ſquare root is 8,062, which expreſſes the length of AC. From which deducting BC=8, there will remain AC=0,062. So that CB or CE is therefore to AB as 8 is to 0,062, that is, as 8000 is to 62. If the diameter of the moon therefore was known, the height of this mountain would alſo be known. This demonſtration is taken from Dr Keill, who ſuppoſes the ſemidiameter of the moon to be 1182 miles; according to which, the mountain muſt be ſomewhat more than nine miles of perpendicular height: but aſtronomers having now determined the moon's ſemidiameter to be only 1090 miles, the height of the mountain will be nearly $8\frac{1}{2}$ miles.

116 Height of the lunar mountains over-rated.

In the former edition of this work, we could not help making ſome remarks on the improbability that the mountains of the moon, a planet ſo much inferior in ſize to the earth, ſhould exceed in ſuch vaſt proportion the higheſt of our mountains, which are computed at little more than one-third of the height juſt mentioned. Our remark is now confirmed by the obſervations of Dr Herſchel. After explaining the method uſed by Galileo, Hevelius, &c. for meaſuring the lunar mountains, he tells us, that the former takes the diſtance of the top of a lunar mountain from the line that divides the illuminated part of the diſk from that which is in the ſhade to be equal to one-twentieth of the moon's diameter; but Hevelius makes it only one twenty-ſixth. When we calculate the height of ſuch a mountain, therefore, it will be found, according to Galileo, almoſt $5\frac{1}{2}$ miles; and according to Hevelius $3\frac{1}{2}$ miles, admitting the moon's diameter to be 2180 miles. Mr Ferguſon, however, ſays (Aſtronomy Explained, § 252.), that ſome of her mountains, by comparing their height with her diameter, are found to be three times higher than the higheſt hills on earth: and Keill, in his Aſtronomical Lectures, has calculated the height of St Catharine's hill, according to the obſervations of Ricciolus, and finds it nine miles. Having premiſed theſe accounts, Dr Herſchel explains his method of taking the height of a lunar mountain from obſervations made when the moon was not in her quadrature, as the method laid down by Hevelius anſwers only to that particular caſe; for in all others the projection muſt appear ſhorter than it really is. "Let SLM, ſays he, or *s l m*, (fig. 96.) be a line drawn from the ſun to the mountain, touching the moon at L or *l*, and the mountain at M or *m*. Then, to an obſerver at E, or *e*, the lines LM, *l m*, will not appear of the ſame length, though the mountain ſhould be of an equal height; for LM will be projected into *o n*, and *l m* into ON. But theſe are the quantities that are taken by the micrometer when we obſerve a mountain to project from the line of illumination. From the obſerved quantity *o n*, when the moon is not in her quadrature, to find LM, we have the following analogy. The triangles *o* OL, *r* ML, are ſimilar; therefore L *o* : LO : : L *r* : LM, or $\frac{LO + on}{Lo} = LM$. but LO is the radius of the moon, and L *r* or *o n* is the obſerved diſtance of the mountain's projection; and L *o* is the ſine of the angle ROL = *o* LS; which we may take to be the diſtance of the ſun from the moon without any material error, and which therefore we may find at any given time from an ephemeris.

117 Dr Herſchel's obſervations on them.

"The teleſcope uſed in theſe obſervations was a Newtonian

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Newtonian reflector of six feet eight inches focal length, to which a micrometer was adapted, consisting of two parallel hairs, one of which was moveable by means of a fine screw. The value of the parts shown by the index was determined by a trigonometrical observation of a known object at a known distance, and was verified by several trials. The power was always 222, excepting where another is expressly mentioned; and this was also determined by experiment, which frequently differs from theory on account of some small errors in the data, hardly to be avoided. The moon having sufficient light, an aperture of no more than four inches was made use of; and, says Dr Herschel, "I believe, that for distinctness of vision, this instrument is perhaps equal to any that ever was made."

With this instrument he observed a prominence, which he calls a *rock*, situated near the *Lacus Niger* of Hevelius, and found that it projected 41.56″. To reduce this into miles, put R for the semidiameter of the moon in seconds, as given by the nautical almanack at the time of observation, and Q for the observed quantity, also in seconds and centesimals; then it will be in general, $R : 1090 :: Q : \frac{1090Q}{R} = on$ in miles.

Thus it is found, that 41.56″ is 46.79 miles. The distance of the sun from the moon at that time was, by the nautical almanack, about 93° 57½′; the sine of which to the radius 1 is .9985, &c. and $\frac{on}{Lo}$ in this case is LM = 46.85 miles. Then, by Hevelius's method, the perpendicular height of the rock is found to be about one mile. At the same time, a great many rocks, situated about the middle of the disk, projected from 25.92″ to 26.56″; which gives *on* about 29.3 miles: so that these rocks are all less than half a mile high.

These observations were made on the 13th of November 1779. On the 13th of January 1780, examining the mountains of the moon, he found that there was not one of them fairly placed on level ground, which is very necessary for an exact measurement of the projection: for if there should be a declivity on the moon before the mountains, or a tract of hills placed so as to cast a shadow upon that part before them which would otherwise be illuminated, the projection would appear too large; and, on the contrary, should there be a rising ground before them, it would appear too little.

Proceeding in this cautious manner, Dr Herschel measured the height of many of the lunar prominences, and draws at last the following conclusions.—"From these observations I believe it is evident, that the height of the lunar mountains in general is greatly over-rated; and that, when we have excepted a few, the generality do not exceed half a mile in their perpendicular elevation. It is not so easy to find any certain mountain exactly in the same situation it has been measured in before; therefore some little difference must be expected in these measures. Hitherto I have not had an opportunity of particularly observing the three mountains mentioned by Hevelius; nor that which Riccioius found to project a sixteenth part of the moon's diameter. If Keill had calculated the height of this last-mentioned hill according to the theorem I had given, he would have found (supposing the observation to have been made, as he says, on the fourth day after new moon) that its perpendicular height could not well be less than between 11 and 12 miles. I shall not fail to take the first opportunity of observing these four, and every other mountain of any eminence; and if other persons, who are furnished with good telescopes and micrometers, would take the quantity of the projection of the lunar mountains, I make no doubt but that we would be nearly as well acquainted with their heights as we are with the elevation of our own. One caution I would beg leave to mention to those who may use the excellent 3½ feet refractors of Mr Dollond. The admirable quantity of light, which on most occasions is so desirable, will probably give the measure of the projection somewhat larger than the true, if not guarded against by proper limitations placed before the object-glass. I have taken no notice of any allowance to be made for the refraction: a ray of light must suffer in passing through the atmosphere of the moon, when it illuminates the top of the mountain, whereby its apparent height will be lessened, as we are too little acquainted with that atmosphere to take it into consideration. It is also to be observed, that this would equally affect the conclusions of Hevelius, and therefore the difference in our inferences would still remain the same."

118 Caution to be observed in using Dollond's telescopes.

In the continuation of his observations, Dr Herschel informs us, that he had measured the height of one of the mountains which had been measured by Hevelius. "Antitaurus (says he), the mountain measured by Hevelius, was badly situated; because Mount Moschus and its neighbouring hills cast a deep shadow, which may be mistaken for the natural convexity of the moon. A good, full, but just measure, 25.105″; in miles, 29.27: therefore LM 31.7 miles, and the perpendicular height not quite half a mile. As great exactness was desired in this observation, it was repeated with very nearly the same result. Several other mountains were measured by the same method; and all his observations concurred in making the height of the lunar mountains much less than what former astronomers had done. Mount Lipulus was found to be near two-thirds of a mile; one of the Apennine mountains, between Lacus Thrasimenus and Pontus Euxinus, measured a mile and a quarter; Mons Armenia, near Taurus, two thirds of a mile; Mons Leucoptera three quarters of a mile. Mons Sacer projected 45.625″; 'but (says he) I am almost certain that there are two very considerable cavities or places where the ground descends below the level of the convexity, just before these mountains; so that these measures must of course be a good deal too large: but supposing them to be just, it follows, that *on* is 50.193 miles, LM = 64 miles, and the perpendicular height above 1¼ miles.'

119 Volcanoes discovered in the moon.

As the moon has on its surface mountains and valleys in common with the earth, some modern astronomers have discovered a still greater similarity, viz. that some of these are really volcanoes, emitting fire as those on earth do. An appearance of this kind was discovered some years ago by Don Ulloa in an eclipse of the sun. It was a small bright spot like a star near the margin of the moon, and which he at that time supposed to have been a hole with the sun's light shining

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ing through it. Succeeding obſervations, however, have induced aſtronomers to attribute appearances of this kind to the eruption of volcanic fire; and Dr Herſchel has particularly obſerved ſeveral eruptions of the lunar volcanoes, the laſt of which he gives an account of in the Phil. Tranſ. for 1787. "April 19. 10 h. 36′ ſidereal time. I perceive (ſays he) three volcanoes in different places of the dark part of the new moon. Two of them are either already nearly extinct, or otherwiſe in a ſtate of going to break out; which perhaps may be decided next lunation. The third ſhows an actual eruption of fire or luminous matter. I meaſured the diſtance of the crater from the northern limb of the moon, and found it 3′ 57.3″; its light is much brighter than the nucleus of the comet which M. Mechain diſcovered at Paris the 10th of this month.

"April 20. 10 h. 2 m. ſidereal time. The volcano burns with greater violence than laſt night. Its diameter cannot be leſs than 3″, by comparing it with that of the Georgian planet: as Jupiter was near at hand, I turned the teleſcope to his third ſatellite, and eſtimated the diameter of the burning part of the volcano to be equal to at leaſt twice that of the ſatellite; whence we may compute that the ſhining or burning matter muſt be above three miles in diameter. It is of an irregular round figure, and very ſharply defined on the edges. The other two volcanoes are much farther towards the centre of the moon, and reſemble large, pretty faint nebulæ, that are gradually much brighter in the middle; but no well defined luminous ſpot can be diſcerned in them. Theſe three ſpots are plainly to be diſtinguiſhed from the reſt of the marks upon the moon; for the reflection of the ſun's rays from the earth is, in its preſent ſituation, ſufficiently bright, with a ten feet reflector, to ſhow the moon's ſpots, even the darkeſt of them; nor did I perceive any ſimilar phenomena laſt lunation, though I then viewed the ſame places with the ſame inſtrument.

"The appearance of what I have called the *actual fire*, or eruption of a volcano, exactly reſembled a ſmall piece of burning charcoal when it is covered by a very thin coat of white aſhes, which frequently adhere to it when it has been ſome time ignited; and it had a degree of brightneſs about as ſtrong as that with which ſuch a coal would be ſeen to glow in faint daylight. All the adjacent parts of the volcanic mountain ſeemed to be faintly illuminated by the eruption, and were gradually more obſcure as they lay at a greater diſtance from the crater. This eruption reſembled much that which I ſaw on the 4th of May in the year 1783, but differed conſiderably in magnitude and brightneſs; for the volcano of the year 1783, though much brighter than that which is now burning, was not nearly ſo large in the dimenſions of its eruption: the former ſeen in the teleſcope reſembled a ſtar of the fourth magnitude as it appears to the naked eye; this, on the contrary, ſhows a viſible diſk of luminous matter very different from the ſparkling brightneſs of ſtar-light."

120 Conjectures concerning her ſubſtance.

Concerning the nature of the moon's ſubſtance there have been many conjectures formed. Some have imagined, that, beſides the light reflected from the ſun, the moon hath alſo ſome obſcure light of her own, by which ſhe would be viſible without being illuminated by the ſunbeams. In proof of this it is urged, that during the time of even total eclipſes the moon is ſtill viſible, appearing of a dull red colour, as if obſcured by a great deal of ſmoke. In reply to this it hath been advanced, that this is not always the caſe; the moon ſometimes diſappearing totally in the time of an eclipſe, ſo as not to be diſcernible by the beſt glaſſes, while little ſtars of the fifth and ſixth magnitudes were diſtinctly ſeen as uſual. This phenomenon was obſerved by Kepler twice, in the years 1580 and 1583; and by Hevelius in 1620. Riccciolus and other Jeſuits at Bologna, and many people throughout Holland, obſerved the ſame on April 14. 1642: yet at Venice and Vienna ſhe was all the time conſpicuous. In the year 1703, Dec. 23. there was another total obſcuration. At Arles, ſhe appeared of a yellowiſh brown; at Avignon, ruddy and tranſparent, as if the ſun had ſhone through her; at Marſeilles, one part was reddiſh and the other very duſky; and at length, though in a clear ſky, ſhe totally diſappeared. The general reaſon for her appearance at all during the time of eclipſes ſhall be given afterwards: but as for theſe particular phenomena, they have not yet, as far as we know, been ſatisfactorily accounted for.

Different conjectures have alſo been formed concerning the ſpots on the moon's ſurface. Some philoſophers have been ſo taken with the beauty of the brighteſt places obſerved in her diſk, that they have imagined them to be rocks of diamonds; and others have compared them to pearls and precious ſtones. Dr Keill and the greateſt part of aſtronomers now are of opinion, that theſe are only the tops of mountains, which by reaſon of their elevation are more capable of reflecting the ſun's light than others which are lower. The duſkiſh ſpots, he ſays, cannot be ſeas, nor any thing of a liquid ſubſtance; becauſe, when examined by the teleſcope, they appear to conſiſt of an infinity of caverns and empty pits, whoſe ſhadows fall within them, which can never be the caſe with ſeas, or any liquid ſubſtance: but, even within theſe ſpots, brighter places are alſo to be obſerved; which, according to his hypotheſis, ought to be the points of rocks ſtanding up within the cavities. Dr Long, however, is of opinion, that ſeveral of the dark ſpots on the moon are really water. May not the lunar ſeas and lakes (ſays he) have iſlands in them, wherein there may be pits and caverns? And if ſome of theſe dark parts be brighter than others, may not that be owing to the ſeas and lakes being of different depths, and to their having rocks in ſome places and flats in others?

It has alſo been urged, that if all the dark ſpots obſerved on the moon's ſurface were really the ſhadows of mountains, or of the ſides of deep pits, they could not poſſibly be ſo permanent as they are found to be; but would vary according to the poſition of the moon with regard to the ſun, as we find ſhadows on earth are varied according as the earth is turned towards or from the ſun. Accordingly it is pretended, that variable ſpots are actually diſcovered on the moon's diſk, and that the direction of theſe is always oppoſite to the ſun. Hence they are found among thoſe parts which are ſooneſt illuminated in the increaſing moon, and in the decreaſing moon loſe their light ſooner than the intermediate ones; running round, and appearing ſometimes longer, and ſometimes ſhorter. The permanent

manent dark spots, therefore, it is said, must be some matter which is not fitted for reflecting the rays of the sun so much as the bright parts do: and this property, we know by experience, belongs to water rather than land; whence these philosophers conclude, that the moon, as well as our earth, is made up of land and seas.

121
Whether the moon has any atmosphere.

It has been a matter of dispute whether the moon has any atmosphere or not. The following arguments have been urged by those who take the negative side.

1. The moon constantly appears with the same brightness when there are clouds in our atmosphere; which could not be the case if she were surrounded with an atmosphere like ours, so variable in its density, and so frequently obscured by clouds and vapours. 2. In an appulse of the moon to a star, when she comes so near it that part of her atmosphere is interposed between our eye and the star, refraction would cause the latter to seem to change its place, so that the moon would appear to touch it later than by her own motion she would do. 3. Some philosophers are of opinion, that because there are no seas or lakes in the moon, there is therefore no atmosphere, as there is no water to be raised up in vapours.

All these arguments, however, have been answered by other astronomers in the following manner. 1. It is denied that the moon appears always with the same brightness, even when our atmosphere appears equally clear. Hevelius relates, that he has several times found in skies perfectly clear, when even stars of the sixth and seventh magnitude were visible, that at the same altitude of the moon, and the same elongation from the earth, and with one and the same telescope, the moon and its maculæ do not appear equally lucid, clear, and conspicuous at all times; but are much brighter and more distinct at some times than at others. From the circumstances of this observation, say they, it is evident that the reason of this phenomenon is neither in our air, in the tube, in the moon, nor in the spectator's eye; but must be looked for in something existing about the moon. An additional argument is drawn from the different appearances of the moon already mentioned in total eclipses, which are supposed to be owing to the different constitutions of the lunar atmosphere.

122
Why the light is not refracted by the moon's atmosphere.

To the second argument Dr Long replies, that Sir Isaac Newton has shown (*Princip.* prop. 37. cor. 5.), that the weight of any body upon the moon is but a third part of what the weight of the same would be upon the earth: now the expansion of the air is reciprocally as the weight that compresses it: the air, therefore, surrounding the moon, being pressed together by a weight, or being attracted towards the centre of the moon by a force equal only to one-third of that which attracts our air towards the centre of the earth, it thence follows, that the lunar atmosphere is only one-third as dense as that of the earth, which is too little to produce any sensible refraction of the stars light. Other astronomers have contended that such refraction was sometimes very apparent. M. Cassini says that he frequently observed Saturn, Jupiter, and the fixed stars, to have their circular figure changed into an elliptical one, when they approached either to the moon's dark or illuminated limb; though they own, that in other occultations no such change could be observed. With regard to the fixed stars, indeed, it has been urged, that, granting the moon to have an atmosphere of the same nature and quantity as ours, no such effect as a gradual diminution of light ought to take place; at least, that we could by no means be capable of perceiving it. Our atmosphere is found to be so rare at the height of 44 miles as to be incapable of refracting the rays of light. This height is the 180th part of the earth's diameter; but since clouds are never observed higher than four miles, we must conclude that the vaporous or obscure part is only one 1980th. The mean apparent diameter of the moon is 31′ 29″, or 1889 seconds: therefore the obscure parts of her atmosphere, when viewed from the earth, must subtend an angle of less than one second; which space is passed over by the moon in less than two seconds of time. It can therefore hardly be expected that observation should generally determine whether the supposed obscuration takes place or not.

The third argument is necessarily inconclusive, because we know not whether there is any water in the moon or not; nor, though this could be demonstrated, would it follow that the lunar atmosphere answers no other purpose than the raising of water into vapour. 123
There is, however, a strong argument in favour of the existence of a lunar atmosphere, taken from the appearance of a luminous ring round the moon in the time of solar eclipses. In the eclipse of May 1. 1706, Captain Stanyan, from Bern in Switzerland, writes, that "the sun was totally darkened there for the space of four minutes and a half: that a fixed star and planet appeared very bright: that his getting out of the eclipse was preceded by a blood-red streak of light from his left limb, which continued not longer than six or seven seconds of time; then part of the sun's disk appeared all on a sudden, brighter than Venus was ever seen in the night; and in that very instant gave light and shadow to things as strong as moon light uses to do." The publisher of this account observes that the red streak of light preceding the emersion of the sun's body, is a proof that the moon has an atmosphere; and its short continuance of five or six seconds shows that its height is not more than the five or six hundredth part of her diameter.

Luminous ring observed about the moon in total eclipses.

Fatio, who observed the same eclipse at Geneva, tells us, that "there was seen during the whole time of the total immersion, a whiteness which seemed to break out from behind the moon, and to encompass her on all sides equally: this whiteness was not well defined on its outward side, and the breadth of it was not a twelfth part of the diameter of the moon. The planet appeared very black, and her disk very well defined within the whiteness which encompassed it about, and was of the same colour as that of a white crown or halo, of about four or five degrees in diameter, which accompanied it, and had the moon for its centre. A little after the sun had begun to appear again, the whiteness, and the crown which had encompassed the moon, did entirely vanish." "I must add (says Dr Long), that this description is a little perplexed, either through the fault of the author or of the translator; for I suppose Fatio wrote in French: however, it plainly appears by it that the moon's atmosphere was visible, surrounded by a light of larger extent, which

I

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I think must be that luminous appearance (the zodiacal light) mentioned from Caffini." Flamftead, who publifhed this account, takes notice, that, according to thefe obfervations, the altitude of the moon's atmofphere cannot be well fuppofed lefs than 180 geographical miles; and that probably this atmofphere was never difcovered before this eclipfe, by reafon of the fmallnefs of the refraction, and the want of proper obfervations.

An account of the fame eclipfe, as it appeared at Zurich, is given by Dr Scheuchzer, in the following words: "We had an eclipfe of the fun, which was both total and annular; total, becaufe the whole fun was covered by the moon; annular, not what is properly fo called, but by refraction: for there appeared round the moon a bright fhining, which was owing to the rays of the fun refracted through the atmofphere of the moon.

Dom. Caffini, from a number of accounts fent him from different parts, fays, that in all thofe places where it was total, during the time of total darknefs, there was feen round the moon a crown or broad circle of pale light, the breadth whereof was about a 12th part of the moon's diameter: that at Montpelier, where the obfervers were particularly attentive to fee if they could diftinguifh the zodiacal light already mentioned, they took notice of a paler light of a larger extent, which furrounded the crown of light before mentioned, and fpread itfelf on each fide of it, to the diftance of four degrees. He then mentions Kepler's opinion, that the crown of light which appears round the moon during the total darknefs in an eclipfe of the fun is caufed by fome celeftial matter furrounding the moon, of fufficient denfity to receive the rays of the fun and fend them to us; and that the moon may have an atmofphere fimilar to that of our earth, which may refract the fun's light.

124 Dr Halley's account of a folar eclipfe in 1715.

A total eclipfe of the fun was obferved on the 22d of April O. S. in the year 1715, by Dr Halley at London, and by M. Louville of the Academy of Sciences at Paris. Dr Halley relates, that "when the firft part of the fun remained on his eaft fide, it grew very faint, and was eafily fupportable to the naked eye even through the telefcope, for above a minute of time before the total darknefs; whereas, on the contrary, the eye could not endure the fplendor of the emerging beams through the telefcope even from the firft moment. To this, two caufes perhaps concurred: the one, that the pupil of the eye did neceffarily dilate itfelf during the darknefs, which before had been much contracted by looking on the fun: the other, that the eaftern parts of the moon, having been heated with a day near as long as 30 of ours, muft of neceffity have that part of its atmofphere replete with vapours raifed by the fo long continued action of the fun; and, by confequence, it was more denfe near the moon's furface, and more capable of obftructing the fun's beams; whereas at the fame time the weftern edge of the moon had fuffered as long a night, during which there might fall in dews all the vapours that were raifed in the preceding long day; and for that reafon, that that part of its atmofphere might be feen much more pure and tranfparent.

"About two minutes before the total immerfion, the remaining part of the fun was reduced to a very fine horn, whofe extremities feemed to lofe their acutenefs, and to become round like ftars; and for the fpace of about a quarter of a minute a fmall piece of the fouthern horn of the eclipfe feemed to be cut off from the reft by a good interval, and appeared like an oblong ftar rounded at both ends; which appearance would proceed from no other caufe but the inequalities of the moon's furface; there being fome elevated parts thereof near the moon's fouthern pole, by whofe interpofition part of that exceedingly fine filament of light was intercepted. A few feconds before the fun was totally hid, there difcovered itfelf round the moon a luminous ring, about a digit, or perhaps a tenth part of the moon's diameter, in breadth. It was of a pale whitenefs, or rather of a pearl colour, feeming to me a little tinged with the colour of the iris, and to be concentric with the moon; whence I concluded it the moon's atmofphere. But the great height of it, far exceeding that of our earth's atmofphere, and the obfervations of fome who found the breadth of the ring to increafe on the weft fide of the moon as the emerfion approached, together with the contrary fentiments of thofe whofe judgments I fhall always revere, make me lefs confident, efpecially in a matter to which I gave not all the attention requifite.

"Whatever it was, this ring appeared much brighter and whiter near the body of the moon than at a diftance from it; and its outward circumference, which was ill defined, feemed terminated only by the extreme rarity of the matter of which it was compofed, and in all refpects refembled the appearance of an enlightened atmofphere feen from far: but whether it belonged to the fun or moon, I fhall not pretend to determine. 125

125 Flafhes of light appear to dart from behind the moon.

During the whole time of the total eclipfe, I kept my telefcope conftantly fixed on the moon, in order to obferve what might occur in this uncommon appearance; and I faw perpetual flafhes or corufcations of light, which feemed for a moment to dart out from behind the moon, now here, now there, on all fides, but more efpecially on the weftern fide, a little before the emerfion; and about two or three feconds before it, on the fame weftern fide, where the fun was juft coming out, a long and very narrow ftreak of dufky but ftrong red light feemed to colour the dark edge of the moon, though nothing like it had been feen immediately after the emerfion. But this inftantly vanifhed after the appearance of the fun, as did alfo the aforefaid luminous ring." 126

126 Mr Louville's obfervations.

Mr Louville relates, that a luminous ring of a filver colour appeared round the moon as foon as the fun was entirely covered by her difk, and difappeared the moment he recovered his light; that this ring was brighteft near the moon, and grew gradually fainter towards its outer circumference, where it was, however, defined; that it was not equally bright all over, but had feveral breaks in it: but he makes no doubt of its being occafioned by the moon's atmofphere, and thinks that the breaks in it were occafioned by the mountains of the moon: he fays alfo, that this ring had the moon, and not the fun, for its centre, during the whole time of its appearance. Another proof brought by him of the moon having an atmofphere is, that, towards the end of the total darknefs, there was feen on that fide of the moon on which the fun was going to appear, a piece of a circle, of a lively red, which might be

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be owing to the red rays that are least refrangible being transmitted through the moon's atmosphere in the greatest quantity: and that he might be assured this redness did not proceed from the glasses of his telescope, he took care to bring the red part into the middle of his glasses.

127 Lightning supposed to be frequent in the moon.

He lays great stress on the streaks of light which he saw dart instantaneously from different places of the moon during the time of total darkness, but chiefly near the eastern edge of the disk: these he takes to be lightning, such as a spectator would see flashing from the dark hemisphere of the earth, if he were placed upon the moon, and saw the earth come between himself and the sun. "Now (says Dr Long) it is highly probable, that if a man had, at any time, a view of that half of the earth where it is night, he would see lightning in some part of it or other." Louville farther observes, that the most mountainous countries are most liable to tempests; and that mountains being more frequent in the moon, and *higher, than on earth* *, thunder and lightning must be more frequent there than with us; and that the eastern side of the moon would be most subject to thunder and lightning, those parts having been heated by the sun for half the month immediately preceding. It must here be observed, that Halley, in mentioning these flashes, says they seemed to come from behind the moon; and Louville, though he says they came sometimes from one part and sometimes from another, owns, that he himself only saw them near the eastern part of the disk; and that, not knowing at that time what it was that he saw, he did not take notice whether the same appearance was to be seen on other parts of the moon or not. He tells us, however, of an English astronomer, who presented the Royal Society with a draught of what he saw in the moon at the time of this eclipse; from which Louville seems to conclude that lightnings had been observed by that astronomer near the centre of the moon's disk. "Now (says Dr Long) thunder and lightning would be a demonstration of the moon having an atmosphere similar to ours, wherein vapours and exhalations may be supported, and furnish materials for clouds, storms, and tempests. But the strongest proof brought by Louville of the moon having an atmosphere is this, that as soon as the eclipse began, those parts of the sun which were going to be hid by the moon grew sensibly palish as the former came near them, suffering beforehand a kind of imperfect eclipse or diminution of light; this would be owing to nothing else but the atmosphere of the moon, the eastern part whereof going before her reached the sun before the moon did.

* See Nº 144. *et seq.*

128 Great height of the lunar atmosphere accounted for.

As to the great height of the lunar atmosphere, which from the breadth of the luminous ring being about a whole digit would upon a calculation come out 180 miles, above three times as high as the atmosphere of the earth, Louville thinks that no objection; since if the moon were surrounded with an atmosphere of the same nature with that which encompasses the earth, the gravitation thereof towards the moon would be but one third of that of our atmosphere towards the earth; and consequently its expansion would make the height of it three times as great from the moon as is the height of our atmosphere from the earth."

The same luminous ring has been observed in other total eclipses, and even in such as are annular, though without the luminous streaks or flashes of lightning above-mentioned; it is even taken notice of by Plutarch: however, some members of the academy at Paris have endeavoured to account for both these phenomena without having recourse to a lunar atmosphere; and for this purpose they made the following experiments: The image of the sun coming through a small hole into a darkened room, was received upon a circle of wood or metal of a diameter a good deal larger than that of the sun's image; then the shadow of this opaque circle was cast upon white paper, and there appeared round it, on the paper, a luminous circle such as that which surrounds the moon. The like experiment being made with a globe of wood, and with another of stone not polished, the shadows of both these cast upon paper were surrounded with a palish light, most vivid near the shadows, and gradually more diluted at a distance from them. They observe also, that the ring round the moon was seen in the eclipse of 1706 by Wurzelbaur, who cast her shadow upon white paper. The same appearance was observed on holding an opaque globe in the sun, so as to cover his whole body from the eye; for, looking at it through a smoked glass, in order to prevent the eye from being hurt by the glare of light it would otherwise be exposed to, the globe appeared with a light resembling that round the moon in a total eclipse of the sun.

129 These phenomena otherwise accounted for.

Thus they solve the phenomenon of the ring seen round the moon by the inflection, or *diffraction* as they call it, of the solar rays passing near an opaque substance. As for the small streaks of light above-mentioned, and which are supposed to be lightning, they explain these by an hypothesis concerning the cavities of the moon themselves; which they consider as concave mirrors reflecting the light of the sun nearly to the same point; and as these are continually changing their situation with great velocity by the moon's motion from the sun, the light which any one of them sends to our eye is seen but for a moment. This, however, will not account for the flashes, if any such there are, seen near the centre of the disk, though it does, in no very satisfactory manner, account for those at the edges.

130 Occultations of the fixed stars by the moon.

It has already been observed, that the occultations of the fixed stars and planets by the moon, in general happen without any kind of refraction of their light by the lunar atmosphere. The contrary, however, has sometimes been observed, and the stars have been seen manifestly to change their shape and colour on going behind the moon's disk. An instance of this happened on the 28th of June N. S. in the year 1715, when an occultation of Venus by the moon happened in the day-time. Some astronomers in France observing this with a telescope, saw Venus change colour for about a minute before she was hid by the moon; and the same change of colour was observed immediately after her emersion from behind the disk. At both times the edge of the disk of Venus that was nearest the moon appeared reddish, and that which was most distant of a bluish colour. These appearances, however, which might have been taken for proofs of a lunar atmosphere, were supposed to be owing to the observers having directed the axis of their telescopes towards the moon. This would necessarily cause any planet or star near the edge of the moon's disk to be seen through those parts of the glasses which are near their circumference,

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ference, and consequently to appear coloured. This was evidently the case from other observations of an occultation of Jupiter by the moon the same year, when no such appearance of refraction could be perceived while he was kept in the middle of the telescope. Maraldi also informs us, that he had observed before this two other occultations of Venus and one of Jupiter; and was always attentive to see whether those planets changed their figure or colour either upon the approach of the moon to cover them, or at their first coming again into sight; but never could perceive any such thing. Nor could he, in a great number of occultations of the fixed stars, perceive the smallest apparent change in any of them, excepting once that a fixed star seemed to increase its distance a little from the moon as it was going to be covered by her; but this, he suspected, might be owing to his telescope being directed so as to have the star seen too far from the middle of its aperture. He concludes, therefore, that the moon has no atmosphere: and he remarks, that at Montpelier, perhaps because the air is clearer there than at London, the luminous ring round the moon appeared much larger than at London; that it was very white near the moon, and gradually decreasing in brightness, formed round her a circular area of about eight degrees in diameter. If, says he, this light was caused by the atmosphere of the moon, of what a prodigious extent must that atmosphere be?

131 Moon has no sensible atmosphere.

We have related all these opinions at full length, in order to put our readers in possession of the arguments that have been advanced upon this subject; but it is now generally admitted, and indeed, scarcely can be denied, that the atmosphere of the moon, if it really has any, is almost entirely insensible.

132 Turns round her axis.

From the spots upon the moon's disk it has been ascertained, that the same hemisphere of that luminary is always directed towards the earth. Hence it follows that she turns round her axis once during every revolution round the earth.

133 Libration of the moon.

Exact observations have ascertained that slight varieties take place respecting the appearances of the moon's disk. The spots are observed alternately to approach towards and recede from the edge of the moon. Those that are very near the edge appear and disappear alternately, making periodical oscillations, which are distinguished by the name of the *libration of the moon*. To form a precise idea of the nature of this libration we must consider that the disk of the moon, seen from the centre of the earth, is terminated by the circumference of a great circle of the moon, perpendicular to a line drawn from the earth's centre to that of the moon. The lunar hemisphere is projected upon the plane of this circle turned towards the earth, and its appearances are due to the movements of rotation of that body relative to its radius vector. If the moon did not revolve round her axis, this radius vector would describe a great circle on the moon's surface, all the points of which would present themselves successively to us. But the moon, revolving in the same time that this radius vector describes the great circle, always keeps the same point of the circle nearly upon the radius, and of course the same hemisphere turned towards the earth. The inequalities of her motion produce the slight variations in her appearance: for the rotation of the moon does not partake sensibly of these irregularities. Hence it varies somewhat relatively to the radius vector, which accordingly cuts successively different points of the surface. Of course the globe of the moon makes oscillations relatively to that radius corresponding to the inequalities of her motions, which alternately conceal from our view and discover to us some parts of her surface.

Farther: the axis of rotation of the moon is not exactly perpendicular to the plane of her orbit. If we suppose the position of this axis fixed, during a revolution of the moon, it inclines more or less to the radius vector, so that the angle formed by these two lines is acute during one part of her revolution, and obtuse during another part of it. Hence the poles of rotation are alternately visible from the earth, and those parts of her surface that are near these poles.

Besides all this, the observer is not placed at the centre of the earth, but at its surface. It is the radius drawn from his eye to the centre of the moon, which determines the middle point of her visible hemisphere. But in consequence of the lunar parallax, it is obvious that this radius must cut the surface of the moon in points sensibly different according to the height of that luminary above the horizon. All these causes concur to produce the *libration* of the moon, a phenomenon which is merely optical, and not connected with her rotation, which relatively to us is perfectly equable; or at least if it be subjected to any irregularities, they are too small to be observed.

This is not the case with the variations in the plane of the moon's equator. While endeavouring to determine its position by the lunar spots, Cassini was led to this remarkable conclusion, which includes the whole astronomical theory of the real libration of that luminary. Conceive a plane passing through the centre of the moon perpendicular to her axis of rotation, and of course coinciding with the plane of her equator; conceive a second plane, parallel to the ecliptic, to pass through the same centre; and also a third plane, which is the mean plane of the lunar orbit: these three planes have a common intersection; the second, placed between the two others, forms with the first an angle of $1^{\circ}.503$, and with the third an angle of $5^{\circ}.14692$; therefore the intersections of the lunar equator with the ecliptic coincide always with the mean nodes of the lunar orbit, and like them have a retrograde motion, which is completed in the period of 6793.3009 days. During that interval the two poles of the equator and lunar orbit describe small circles parallel to the ecliptic, enclosing between them the pole of the ecliptic, so that these three poles are constantly upon a great circle of the heavenly sphere. 134 Theory of it.

Chap. III. *Of the Planets.*

Amidst the infinite variety of stars which occupy a place in the sphere of the heavens, and which occupy nearly the same relative position with respect to each other, there are eight which may be observed to move in a very complicated manner, but following certain precise laws, for they always commence the same motions again after every period. The motions of these

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these ſtars, called *planets*, conſtitutes one of the principal objects of aſtronomy. These planets are called

1. Mercury.	5. Pallas.
2. Venus.	6. Jupiter.
3. Mars.	7. Saturn.
4. Ceres.	8. Herſchel.

Mercury and Venus never ſeparate from the ſun farther than certain limits; the reſt ſeparate to all the poſſible angular diſtances. The movements of all theſe bodies are included in a zone of the heavenly ſphere called the *zodiac*. This zone is divided into two equal parts by the ecliptic. Its breadth was formerly conſidered as only about 16°; but it muſt be much increaſed if the orbits of Ceres and Pallas, the two newly diſcovered planets, are to be comprehended in it. It will be proper to conſider the motions and appearances of each of theſe planets. This will be the ſubject of the following ſections.

Sect. I. *Of Mercury.*

Mercury is a ſmall ſtar, but emits a very bright white light: though, by reaſon of his always keeping near the ſun, he is ſeldom to be ſeen; and when he does make his appearance, his motion towards the ſun is ſo ſwift, that he can only be diſcerned for a ſhort time. He appears a little after ſunſet, and again a little before ſunriſe.

135 His apparent motions. Mercury never goes to a greater diſtance from the ſun than about 27°.5; ſo that he is never longer in ſetting after the ſun than an hour and 50 minutes; nor does he ever riſe ſooner than 1 hour and 50 minutes before that luminary. Very frequently, he goes ſo near the ſun as to be loſt altogether in his rays. When he begins to make his appearance in the evening after ſunſet, he can ſcarcely at firſt be diſtinguiſhed in the rays of the twilight. But the planet diſengages itſelf more and more, and is ſeen at a greater diſtance from the ſun every ſucceſſive evening; and having got to the diſtance of about 22°.5, it begins to return again. During this interval, the motion of Mercury referred to the ſtars is direct; but when it approaches within 18° of the ſun it appears for ſome time ſtationary; and then its motion begins to be retrograde. The planet continues to approach the ſun, and at laſt plunges into his rays in the evening, and diſappears. Soon after, it may be perceived in the morning, before ſunriſe, ſeparating farther and farther from the ſun, his motion being retrograde, as before he diſappeared. At the diſtance of 18° it becomes ſtationary, and aſſumes a direct motion, continuing, however, to ſeparate till it comes to 22.5° of diſtance; then it returns again to the ſun, plunges into his rays, and appears ſoon after in the evening, after ſunſet, to repeat the ſame career. The angular diſtance from the ſun, which the planet reaches on both ſides of that luminary, varies from 16° to nearly 28°.

The duration of a complete oſcillation, or the interval of time that elapſes before the planet returns again to the point from which it ſet out, varies alſo from 100 to 130 days. The mean arc of his retrogradation is about $13\frac{1}{2}$°; its mean duration 23 days. But the quantity differs greatly in different retrogradations. In general, the laws of the movements of Mercury are very complicated; he does not move exactly in the plane of the ecliptic; ſometimes he deviates from it more than 5°.

Some conſiderable time muſt have elapſed before aſtronomers ſuſpected that the ſtars which were ſeen approaching the ſun in the evening and in the morning were one and the ſame. The circumſtance, however, of the one never being ſeen at the ſame time with the other would gradually lead them to the right concluſion.

136 Diameter. The apparent diameter of Mercury varies as well as that of the ſun and moon, and this variation is obviouſly connected with his poſition relatively to the ſun, and with the direction of his movement. The diameter is at its minimum when the planet plunges into the ſolar rays in the morning, or when it diſengages itſelf from them: it is at its maximum when the planet plunges into the ſolar rays in the evening, or when it diſengages itſelf from them in the evening; that is to ſay, when the planet paſſes the ſun it its retrograde motion, its diameter is the greateſt poſſible; when it paſſes the ſun in its direct motion, it is the ſmalleſt poſſible;—and the mean length of the apparent diameter of Mercury is 11″.

137 Nature. Sometimes, when the planet diſappears during its retrograde motion, that is to ſay, when it plunges into the ſun's rays in the evening, it may be ſeen croſſing the ſun under the form of a black ſpot, which deſcribes a chord along the diſk of the ſun. This black ſpot is recognized to be the planet by its poſition, its apparent diameter, and its retrograde motion. Theſe *tranſits* of Mercury, as they are termed, are real annular eclipſes of the ſun: they demonſtrate that the planet is an opaque body, and that it borrows its light from the ſun. When examined by means of teleſcopes magnifying about 200 or 300 times, he appears equally luminous throughout his whole ſurface, without the leaſt dark ſpot. But he exhibits the ſame difference of phaſes with the moon, being ſometimes horned, ſometimes gibbous, and ſometimes ſhining almoſt with a round face, though not entirely full, becauſe his enlightened ſide is never turned directly towards us; but at all times perfectly well defined without any ragged edge, and perfectly bright. Like the moon, the creſcent is always turned towards the ſun. Theſe different phaſes throw conſiderable light on the orbit of Mercury.

Sect. II. *Of Venus.*

Venus, the moſt beautiful ſtar in the heavens, known by the names of the *morning* and *evening ſtar*, likewiſe keeps near the ſun, though ſhe recedes from him almoſt double the diſtance of Mercury. She is never ſeen in the eaſtern quarter of the heavens when the ſun is in the weſtern; but always ſeems to attend him in the evening, or to give notice of his approach in the morning.

The planet Venus preſents the ſame phenomena with Mercury; but her different phaſes are much more ſenſible, her oſcillations wider, and of longer duration. Her greateſt diſtance from the ſun varies from 45° to nearly 48°, and the mean duration of a complete oſcillation is 584 days.

138 Her apparent motions. Venus has been ſometimes ſeen moving acroſs the ſun's diſk in the form of a round black ſpot, with an apparent diameter of about 59″. A few days after this has been obſerved, Venus is ſeen in the morning,

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west of the sun, in the form of a fine crescent, with the convexity turned toward the sun. She moves gradually westward with a retarded motion, and the crescent becomes more full. In about ten weeks she has moved 46° west of the sun, and is now a semicircle, and her diameter is 26″. She is now stationary. She then moves eastward with a motion gradually accelerated, and overtakes the sun about $9\frac{1}{2}$ months after having been seen on his disk. Some time after, she is seen in the evening, east of the sun, round, but very small. She moves eastward, and increases in diameter, but loses of her roundness, till she gets about 46° east of the sun, when she is again a semicircle. She now moves westward, increasing in diameter, but becoming a crescent like the waning moon; and, at last, after a period of nearly 584 days, comes again into conjunction with the sun with an apparent diameter of 59″.

The mean arc of her retrogradation is about 16°, and its mean duration is 42 days. She does not move exactly in the plane of the ecliptic, but deviates from it several degrees. Like Mercury, she sometimes crosses the sun's disk. The duration of these transits, as observed from different parts of the earth's surface, are very different: this is owing to the parallax of Venus, in consequence of which different observers refer to different parts of the sun's disk, and see her describe different chords on that disk. In the transit which happened in 1769, the difference of its duration, as observed at Otaheite and at Wardhuys in Lapland, amounted to 23 m. 10 sec. This difference gives us the parallax of Venus, and of course her distance from the earth during a conjunction. The knowledge of this parallax enables us, by a method to be afterwards described, to ascertain that of the sun, and consequently to discover its distance from the earth.

The great variations of the apparent diameter of Venus demonstrate that her distance from the earth is exceedingly variable. It is largest when the planet passes over the surface of the sun. Her mean apparent diameter is 58″.

139 Revolution round her axis.

From the movement of certain spots upon the surface of Venus, it has been concluded that she revolves round her axis once in 24 hours; but this requires to be corrected by future observations. It is extremely difficult to perceive or examine these spots in our climate. The subject merits the attention of astronomers farther to the south, in more favourable circumstances. The following detail will show the uncertainty which has prevailed among astronomers respecting these spots.

140 Spots when first discovered on the disk of Venus.

Dr Long informs us, that the earliest account he had met with of any spots seen by means of the telescope on the disk of Venus was in a collection of letters printed at Paris in 1665, in one of which Mr Auzout relates his having received advice from Poland that Mr Burratini had, by means of large telescopes, seen spots upon the planet Venus similar to those upon the moon.

141 Cassini's observations.

In 1667, Cassini, in a letter to Mr Petit, mentions his having for a long time carefully observed Venus through an excellent telescope made by Campani, in order to know whether that planet revolved on its axis or not, as he had before found Jupiter and Mars to do. But though he then observed some spots upon her, he says, that even when the air was quiet and clear, they appeared faint, irregular, and not well defined; so that it was difficult to have such a distinct view of any of them as to be certain that it was the same spot which was seen again in any subsequent observation; and this difficulty was increased, in the first place, when Venus was in her inferior semicircle; because at that time she must be viewed through the thick vapours near the horizon; though otherwise it was most proper, on account of her being then nearest to us. In the second place, if we would observe her at some height above those vapours, it could only be for a short time; and thirdly, when she is low in her inferior circle, and at that time nearest the earth, the enlightened part of her is too small to discover any motion in it. He was therefore of opinion, that he should succeed better in his observations when the planet was about its mean distance from us, showing about one half of her enlightened hemisphere; at which time also he could observe her for a much longer time above the gross atmospherical vapours. His first appearance of success was October 14. 1666, at three quarters past five in the evening; when he saw a bright spot (fig. 37.), but could not then view that spot long enough to draw any inference concerning the planet's motion. He had no farther success till the 20th of April the following year; when, about a quarter of an hour before sunrise, he began again to perceive on the disk of Venus, now about half enlightened, a bright part near the section, distant from the southern horn a little more than a fourth part of the diameter of the disk, and near the eastern edge. He took notice also of a darkish oblong spot nearer to the northern than the southern horn: at sunrise the bright part was advanced farther from the southern horn than when he first observed it; but though he was pleased to find that he had now a convincing proof of the planet's motion, he was surprised that the spots moved from south to north in the lower part of the disk, and from north to south in the upper part; a kind of motion of which we have no example except in the librations of the moon. This, however, was occasioned by the situation of the planet's axis. Cassini expected to have found the rotation of Venus similar to that of Jupiter and Mars, both of which have their axis perpendicular to their respective orbits, and turn round according to the order of the signs; so that in each of them the motion of the inferior half of their respective globe, or that part next the sun, is from east to west; in the superior half from west to east; but in Venus, whose axis is inclined 75 degrees towards her orbit, the coincidence is so near, that one half of her disk appears to move from south to north, the other from north to south.

142 Why the spots seem to move from south to north.

143 Particular account of the appearances of the spots at different times.

On the 21st of April, at sunrise, the bright part was a good way off the section, and about a fourth part of the diameter distant from the southern horn. When the sun was eight degrees six minutes high, it seemed to be got beyond the centre, and was cut through by the section. At the time the sun was seven degrees high, the section cut it in the middle, which showed its motion to have some inclination towards the centre.

May 9. a little before sunrise, the bright spot was seen near the centre, a little to the northward, with two obscure ones situated between the section and the circumference, at a distance from each other, equal to that

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that of each of them from the neareſt angular point or horn of the planet. The weather being at that time clear, he obſerved for an hour and half a quarter the motion of the bright ſpot, which ſeemed to be exactly from ſouth to north, without any ſenſible declination to eaſt or weſt. A variation was at the ſame time perceived in the darkiſh ſpot too great to be aſcribed to any optical cauſe. The bright ſpot was alſo ſeen on the 10th and 13th days of May before ſunriſe between the northern horn and the centre, and the ſame irregular change of darkiſh ſpots was taken notice of; but as the planet removed to a greater diſtance from the earth, it became more difficult to obſerve theſe appearances. The above phenomena are repreſented as they occurred, in fig. 19 to 25.

144 Caſſini's concluſions concerning the revolution of Venus on her axis.

But though, from the appearances juſt now related, M. Caſſini was of opinion that Venus revolved on her axis, he was by no means ſo poſitive in this matter as with regard to Mars and Jupiter. "The ſpots on theſe (ſays he) I could attentively obſerve for a whole night, when the planets were in oppoſition to the ſun: I could ſee them return to the ſame ſituation, and conſider their motion during ſome hours, and judge whether they were the ſame ſpots or not, and what time they took in turning round: but it was not the ſame with the ſpots of Venus; for they can be obſerved only for ſo ſhort a time, that it is much more difficult to know with certainty when they return into the ſame ſituation. I can, however, ſuppoſing that the bright ſpot which I obſerved on Venus, and particularly this year, was the ſame, ſay that ſhe finiſhes her motion, whether of rotation or libration, in leſs than a day; ſo that, in 23 days nearly, the ſpot comes into the ſame ſituation on nearly the ſame hour of the day, though not without ſome irregularity. Now (ſuppoſing the bright ſpot obſerved to be always the ſame) whether this motion is an entire turning round, or only a libration, is what I dare not poſitively affirm."

145 Difficulties attending theſe obſervations.

In 1669, M. Caſſini again obſerved Venus through a teleſcope, but could not then perceive any ſpots upon her ſurface; the reaſon of which Du Hamel conjectures to have been the fluctuation of the vapours near the horizon, which prevented them from being viſible. However, we hear nothing more of any ſpots being ſeen on her diſk till the year 1726; when, on the 9th of February, Bianchini, with ſome of Campani's teleſcopes of 90 and 100 Roman palms, began to obſerve the planet at the altitude of 40° above the horizon, and continued his obſervation till, by the motion of ſeveral ſpots, he determined the poſition of her axis to be inclined as above-mentioned, that the north pole pointed at a circle of latitude drawn through the 20th degree of Aquarius, elevated 15° or 20° above the orbit of Venus. He delineated alſo the figures of ſeveral ſpots which he ſuppoſed to be ſeas, and complimented the king of Portugal and ſome other great men by calling them by their names. Though none of Bianchini's obſervations were continued long enough to know whether the ſpots, at the end of the period aſſigned for the rotation of the planet, would have been in a different ſituation from what they were at the beginning of it; yet, from obſervations of two and of four days, he concluded the motion of the ſpots to be at the rate of 15° per day; at which advance the planet muſt turn round either once in 24 days or in 23 hours; but without farther obſervation it could not be determined which of the two was the period of revolution; for if an obſerver ſhould at a particular hour, ſuppoſe ſeven in the evening, mark exactly the place of a ſpot, and at the ſame hour next evening find the ſpot advanced 15°, he would not be able to determine whether the ſpot had advanced only 15°, or had gone once quite round with the addition of 15° more in part of another rotation. Mr Bianchini, however, ſuppoſes Venus to revolve in 24 days eight hours; the principal proof adduced for which is an obſervation of three ſpots, ABC, being ſituated as in fig. 26. when they were viewed by himſelf and ſeveral perſons of diſtinction for about an hour, during which they could not perceive any change of place. The planet being then hid behind the Barbarini palace, they could not have another view of her till three hours after, when the ſpots ſtill appeared unmoved. "Now (ſays Mr Bianchini) if her rotation were ſo ſwift as to go round in 23 hours, in this ſecond view, three hours after the former, the ſpots muſt have advanced near 50 degrees; ſo that the ſpot C would have been gone off at R, the ſpot B would have ſucceeded into the place of C, the ſpot A into the place of B, and there would have been no more but two ſpots, A and B, to have been ſeen."

146 Bianchini's obſervations.

147 Doubts concerning the time ſhe takes in revolving round her axis.

148 Diſpute between Caſſini and Bianchini.

Caſſini, the ſon, in a memoir for 1732, denies the concluſion of Bianchini to be certain. He ſays, that during the three hours interval, the ſpot C might be gone off the diſk, and the ſpot B got into the place thereof, where, being near the edge, it would appear leſs than in the middle. That A, ſucceeding into the place of B, would appear larger than it had done near the edge, and that another ſpot might come into the place of A; and there were other ſpots beſides theſe three on the globe of the planet, as appears by the figures of Bianchini himſelf, particularly one which would naturally come in the place of A. That if the rotation of Venus be ſuppoſed to be in 23 hours, it will agree with Bianchini's obſervations, as well as with thoſe of his father; but that, on the other ſuppoſition, the latter muſt be entirely rejected as erroneous: and he concludes with telling us, that Venus had frequently been obſerved in the moſt favourable times by Mr Maraldi and himſelf with excellent teleſcopes of 80 and 100 feet focus, without their being able to ſee any diſtinct ſpot upon her diſk. "Perhaps (ſays Dr Long) thoſe ſeen by Bianchini had diſappeared, or the air in France was not clear enough; which laſt might be the reaſon why his father could never ſee thoſe ſpots in France which he had obſerved in Italy, even when he made uſe of the longeſt teleſcopes." Neither of theſe aſtronomers take notice of any indentings in the curve which divides the illuminated part from the dark in the diſk of Venus, though in ſome views of that planet by Fontana and Ricciolus, the curve is indented; and it has from thence been concluded, that the ſurface of the planet is mountainous like that of the moon. This had alſo been ſuppoſed by Burratini, already mentioned; and a late writer has obſerved, that, "when the air is in a good ſtate for obſervation, mountains like thoſe of the moon may be obſerved with a very powerful teleſcope."

149 Caſſini diſcovers her ſatellites.

Caſſini, beſides the diſcovery of the ſpots on the diſk of Venus by which he was enabled to aſcertain her revolution

volution on an axis, had alſo a view of her ſatellite or moon, of which he gives the following account.— "A. D. 1686, Auguſt 28th, at 15 minutes after four in the morning, looking at Venus with a teleſcope of 34 feet, I ſaw, at the diſtance of one-third of her diameter eaſtward, a luminous appearance, of a ſhape not well defined, that ſeemed to have the ſame phaſe with Venus, which was then gibbous on the weſtern ſide. The diameter of this phenomenon was nearly equal to a fourth part of the diameter of Venus. I obſerved it attentively for a quarter of an hour, and having left off looking at it for four or five minutes, I ſaw it no more; but day-light was then advanced. I had ſeen a like phenomenon which reſembled the phaſe of Venus, Jan. 25th, A. D. 1672, from 52 minutes after ſix in the morning to two minutes after ſeven, when the brightneſs of the twilight made it diſappear. Venus was then horned; and this phenomenon, the diameter whereof was nearly a fourth part of the diameter of Venus, was of the ſame ſhape. It was diſtant from the ſouthern horn of Venus, a diameter of the planet, on the weſtern ſide. In theſe two obſervations, I was in doubt whether it was not a ſatellite of Venus of ſuch a conſiſtence as not to be very well fitted to reflect the light of the ſun; and which, in magnitude, bore nearly the ſame proportion to Venus as the moon does to the carth, being at the ſame diſtance from the ſun and the earth as Venus was, the phaſes whereof it reſembled. Notwithſtanding all the pains I took in looking for it after theſe two obſervations, and at divers other times, in order to complete ſo conſiderable a diſcovery, I was never able to ſee it. I therefore ſuſpended my judgment of this phenomenon. If it ſhould return often, there will be theſe two epochas, which, compared with other obſervations, may be of uſe to find out the periodical time of its return, if it can be reduced to any rule."

150 Diſcovered alſo by Mr Short.

A ſimilar obſervation was made by Mr Short on the 23d of October 1740, about ſunriſe. He uſed at this time a reflecting teleſcope of about 16.5 inches, which magnified between 50 and 60 times, with which he perceived a ſmall ſtar at about 10′ diſtance from Venus, as meaſured by the micrometer; and, putting on a magnifying power of 240 times, he found the ſtar put on the ſame appearance with the planet herſelf. Its diameter was ſomewhat leſs than a third of that of the primary, but its light was leſs vivid, though exceedingly ſharp and well defined. The ſame appearance continued with a magnifying power of 140 times. A line, paſſing through the centre of Venus and it made an angle of 18 or 20 degrees with the equator: he ſaw it ſeveral times that morning for about the ſpace of an hour, after which he loſt ſight of it, and could never find it again.

From this time the ſatellite of Venus, though very frequently looked for by aſtronomers, could never be perceived, which made it generally believed that Caſſini and Mr Short had been miſtaken; but as the tranſits of the planet over the ſun in 1761 and 1769 ſeemed to promiſe a greater certainty of finding it, the ſatellite was very carefully looked for by almoſt every one who had an opportunity of ſeeing the tranſit, but generally without ſucceſs. Mr Baudouin at Paris had provided a teleſcope of 25 feet, in order to obſerve the paſſage of the planet over the ſun, and to look for its ſatellite; but he did not ſucceed either at that time or in the months of April and May following. Mr Montaigne, however, one of the members of the Society of Limoges, had better ſucceſs. On the 3d of May 1761, he perceived, about half an hour after nine at night, at the diſtance of 20′ from Venus, a ſmall creſcent, with the horns pointing the ſame way as thoſe of the planet; the diameter of the former being about one-fourth of that of the latter; and a line drawn from Venus to the ſatellite making an angle with the vertical of about 20° towards the ſouth. But though he repeated this obſervation ſeveral times, ſome doubt remained whether it was not a ſmall ſtar. Next day he ſaw the ſame ſtar at the ſame hour, diſtant from Venus about half a minute, or a minute more than before, and making with the vertical an angle of 10° below on the north ſide; ſo that the ſatellite ſeemed to have deſcribed an arc of about 30°, whereof Venus was the centre, and the radius 20′. The two following nights were hazy, ſo that Venus could only be ſeen; but on the 7th of May, at the ſame hour as before, he ſaw the ſatellite again above Venus, and on the north ſide, at the diſtance of 25′ or 26′ upon a line which made an angle of about 45° with the vertical towards the right hand. The light of the ſatellite was always very weak, but it had the ſame phaſes with its primary, whether viewed together with it in the field of his teleſcope or by itſelf. The teleſcope was nine feet long, and magnified an object between 40 and 50 times, but had no micrometer; ſo that the diſtances above-mentioned are only from eſtimation.

151 Seen by Mr Montaigne at the tranſit in 1761.

Fig. 27. repreſents the three obſervations of Mr Montaigne. V is the planet Venus; ZN the vertical. EC, a parallel to the ecliptic, making them an angle with the vertical of 45°; the numbers 3, 4, 7, mark the ſituations of the ſatellite on the reſpective days. From the figure it appears that the points 3 and 7 would have been diametrically oppoſite, had the ſatellite gone 15° more round the point V at the laſt obſervation; ſo that in four days it went through 155°. Then, as 155° is to four days or 96 hours, ſo is 360 to a fourth number, which gives 9 days 7 hours for the whole length of the ſynodical revolution. Hence Mr Baudouin concluded, that the diſtance of this ſatellite was about 60 of the ſemidiameters of Venus from its ſurface; that its orbit cut the ecliptic nearly at right angles; had its aſcending node in 22° of Virgo; and was in its greateſt northern digreſſion on the 7th at nine at night; and he ſuppoſed that at the tranſit of the primary the ſatellite would be ſeen accompanying it. By a ſubſequent obſervation, however, on the 11th of May, he corrected his calculation of the periodical time of the ſatellite, which he now enlarged to 12 days; in conſequence of which he found that it would not paſs over the diſk of the ſun along with its primary, but go at the diſtance of above 20′ from his ſouthern limb; though if the time of its revolution ſhould be 15 hours longer than 12 days, it might then paſs over the ſun after Venus was gone off. He imagined the reaſon why this ſatellite was ſo difficult to be obſerved might be, that one part of its globe was cruſted over with ſpots, or otherwiſe unfit to reflect the light of the ſun. By comparing the periodical time of this ſatellite with that of our moon, he computed the quantity of matter in Venus to be nearly equal

152 Why this ſatellite is ſo difficult to be ſeen.

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equal to that in our earth; in which case it must have considerable influence in changing the obliquity of the ecliptic, the latitudes and longitudes of stars, &c.

It is now known that this supposed satellite of Cassini was merely an optical deception.

153 Observations concerning the atmosphere of Venus.

In the Philosophical Transactions for 1761, Mr Hirst gives an account of his having observed an atmosphere round the planet Venus. The observations were made at Fort St George; and looking attentively at that part of the sun's disk where he expected the planet would enter, he plainly perceived a faint shade or penumbra; on which he called out to his two assistants, "'Tis a coming!" and two or three seconds after, the first external contact took place, in the moment whereof all the three agreed; but he could not see the penumbra after the egress: and of the other two gentlemen, one had gone home, and the other lost the planet out of the field of his telescope. Mr Dunn at Chelsea saw a penumbra, or small diminution of light, that grew darker and darker for about five seconds before the internal contact preceding the egress; from whence he determines that Venus is surrounded with an atmosphere of about 50 geographical miles high. His observations, he tells us, were made with an excellent six-feet Newtonian reflector, with a magnifying power of 110, and of 220 times: he had a clear dark glass next his eye, and the sun's limb appeared well defined; but a very narrow waterish penumbra appeared round Venus. The darkest part of the planet's phasis was at the distance of about a sixth part of her diameter from its edge; from which an imperfect light increased to the centre, and illuminated round about.

In the northern parts of Europe this penumbra could not be seen. Mr Wargentin, who communicated several observations of the first external contact, says, that he could not mark the time exactly, because of the undulation of the limb of the sun; but thought it very remarkable that, at the egress, the limb of Venus that was gone off the sun showed itself with a faint light during almost the whole time of emersion. Mr Bergman, who was then at the observatory at Upsal, begins his account at the time when three-fourths of the disk of the planet was entered upon that of the sun; and he says, that the part which was not come upon the sun was visible, though dark, and surrounded by a crescent of faint light, as in fig. 28.: but this appearance was much more remarkable at the egress; for as soon as any part of the planet was got off the sun, that part was visible with a like crescent, but brighter, fig. 29. As more of the planetary disk went off that of the sun, however, that part of the crescent which was farthest from the sun grew fainter, and vanished, until at last only the horns could be seen, as in fig. 30. The total ingress was not instantaneous: but, as two drops of water, when about to part, form a ligament between them; so there was a dark swelling stretched out between Venus and the sun, as in fig. 31.; and when this ligament broke, the planet appeared to have got about an eighth part of her diameter from the nearest limb of the sun, fig. 32.: he saw the like appearance at going off, but not so distinct, fig. 33. Mr Chappe likewise took notice, that the part of Venus which was not upon the sun was visible during part of the time of ingress and egress; that it was farther surrounded by a small luminous ring of a deep yellow near the place that appeared in the form of a crescent, which was much brighter at the going off than coming upon the sun; and that, during the whole time the disk of Venus was upon the sun, he saw nothing of it. The time of total ingress was instantaneous like a flash of lightning; but at the egress the limb of the sun began to be obscured three seconds before the interior contact. Some of the French astronomers attributed this luminous ring round Venus to the inflection of the sun's rays, as they also do the light seen round the moon in solar eclipses; but Mr Chappe supposes it to have been owing to the sun enlightening more than one half of the planetary globe, though he owns this cause not to be altogether sufficient. Mr Fouchy, who observed the transit at La Muette in France, perceived, during the whole time, a kind of ring round Venus, brighter than the rest of the sun, which became fainter the farther it went from the planet, but appeared more vivid in proportion as the sun was clearer. Mr Ferner, who observed at the same place, confirms the testimony of Mr Fouchy. "During the whole time (says he) of my observing with the telescope, and the blue and green glasses, I perceived a light round about Venus, which followed her like a luminous atmosphere more or less lively, according as the air was more or less clear. Its extent altered in the same manner; nor was it well terminated, throwing out, as it were, some feeble rays on all sides."

154 Dr Long's opinion on these observations.

"I am not clear (says Dr Long) as to the meaning of the luminous circle here mentioned; whether, when the whole planet was upon the sun, they saw a ring of light round it, distinct from the light of the sun; or whether they mean only the light which surrounded that part of Venus that was not upon the sun." Mr Chappe takes this and other accounts of the observations made in France in this latter sense; and though he sometimes called the luminous part of the crescent that surrounded the part of the planet not upon the sun a ring, he explains himself that he did so, because at the coming upon the sun he perceived it at one side of the planet, and on the opposite side on its going off: for which reason he supposed that it surrounded it on all sides. See fig. 34, 35.

Sect. III. *Of Mars.*

The two planets which we have just described, appear to accompany the sun like satellites, and their mean motion round the earth is the same with that luminary. The remaining planets go to all the possible angular distances from the sun. But their motions have obviously a connection with the sun's position.

Mars is of a red fiery colour, and always gives a much duller light than Venus, though sometimes he equals her in size. He is not subject to the same limitation in his motions as Mercury or Venus; but appears sometimes very near the sun, and sometimes at a great distance from him; sometimes rising when the sun sets, or setting when he rises. Of this planet it is remarkable, that when he approaches any of the fixed stars, which all the planets frequently do, these stars change their colour, grow dim, and often become totally invisible, though at some little distance from the body of the planet: but Dr Herschel thinks this has been exaggerated by former astronomers.

Mars

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Mars appears to move from west to east round the earth. The mean duration of his sidereal revolution is 686.979579 days. His motion is very unequal. When we begin to perceive this planet in the morning when he begins to separate from the sun, his motion is direct and the most rapid possible. This rapidity diminishes gradually, and the motion ceases altogether when the planet is about 137° distant from the sun; then his motion becomes retrograde, and increases in rapidity till he comes into opposition with the sun. It then gradually diminishes again, and becomes nothing when Mars approaches within 137° of the sun. Then the motion becomes direct after having been retrograde for 73 days, during which interval the planet described an arch of about 16°. Continuing to approach the sun, the planet at last is lost in the evening in the rays of that luminary. All these different phenomena are renewed after every opposition of Mars; but there are considerable differences both in the extent and duration of his retrogradations.

Mars does not move exactly in the plane of the ecliptic, but deviates from it several degrees. His apparent diameter varies exceedingly. His mean apparent diameter is 27″, and it increases so much, that when the planet is in opposition, the apparent diameter is 81″. Then the parallax of Mars becomes sensible, and about double that of the sun.

The disk of Mars changes its form relatively to its position with regard to the sun, and becomes oval. Its phases shew that it derives its light from that luminary. The spots observed on its surface have informed astronomers that it moves round its axis from west to east in 1.02733 days, and its axis is inclined to the ecliptic at an angle of about 59.7°.

155 Spots when first seen on Mars.

They were first observed in 1666 by Cassini at Bologna with a telescope of Campani about 16½ feet long; and continuing to observe them for a month, he found they came into the same situation in 24 hours and 40 minutes. The planet was observed by some astronomers at Rome with longer telescopes made by Eustachio Divini; but they assigned to it a rotation in 13 hours only. This, however, was afterwards shown by Mr Cassini to have been a mistake, and to have arisen from their not distinguishing the opposite sides of the planet, which it seems have spots pretty much alike. He made further observations on the spots of this planet in 1670; from whence he drew an additional confirmation of the time the planet took to revolve. The spots were again observed in subsequent oppositions; particularly for several days in 1704 by Maraldi, who took notice that they were not always well defined, and that they not only changed their shape frequently in the space between two oppositions, but even in the space of a month. Some of them, however, continued of the same form long enough to ascertain the time of the planet's revolution. Among these there appeared this year an oblong spot, resembling one of the belts of Jupiter when broken. It did not reach quite round the body of the planet; but had, not far from the middle of it, a small protuberance towards the north, so well defined that he was thereby enabled to settle the period of its revolution at 24 hours 39 minutes; only one minute less than what Cassini had determined it to be. See fig. 45.

The near approach of Mars to the earth in 1719, gave a much better opportunity of viewing him than had been obtained before; as he was then within 2½° of his perihelion, and at the same time the opposition to the sun. His apparent magnitude and brightness were thus so much increased, that he was by the vulgar taken for a new star. His appearance at that time, as seen by Maraldi through a telescope of 34 feet long, is represented fig. 37. There was then a long belt that reached half way round, to the end of which another shorter belt was joined, forming an obtuse angle with the former, as in fig. 38. This angular point was observed on the 19th and 20th of August, at 11 hours 15 minutes, a little east of the middle of the disk; and 37 days after, on the 25th and 26th of September, returned to the same situation. This interval, divided by 36, the number of revolutions contained in it gives 24 hours 40 minutes for the period of one revolution; which was verified by another spot of a triangular shape, one angle whereof was towards the north pole, and the base towards the south, which on the 5th and 6th of August appeared as in fig. 39. and after 72 revolutions returned to the same situation on the 16th and 17th of October. The appearances of Mars, as delineated by Mr Hook, when viewed through a 36 feet telescope, are represented fig. 40. He appeared through this instrument as big as the full moon. Some of the belts of this planet are said to be parallel to his equator; but that seen by Maraldi was very much inclined to it.

156 Bright spots about the poles of Mars.

Besides these dark spots, former astronomers took notice that a segment of his globe about the south pole exceeded the rest of his disk so much in brightness, that it appeared beyond them as if it were the segment of a larger globe. Maraldi informs us, that this bright spot had been taken notice of for 60 years, and was more permanent than the other spots on the planet. One part of it is brighter than the rest, and the least bright part is subject to great changes, and has sometimes disappeared.

A similar brightness about the north pole of Mars was also sometimes observed; and these observations are now confirmed by Dr Herschel, who has viewed the planet with much better instruments, and much higher magnifying powers, than any other astronomer ever was in possession of. His observations were made with a view to determine the figure of the planet, the position of his axis, &c. A very particular account of them is given in the 74th volume of the Philosophical Transactions, but which our limits will not allow us to insert. Fig. 41 to 64. show the particular appearances of Mars, as viewed on the days there marked. The magnifying powers he used were sometimes as high as 932; and with this the south polar spot was found to be in diameter 41‴. Fig. 65 shows the connection of the other figures marked 56, 57, 58, 59, 60, 61, 62, which complete the whole equatorial succession of spots on the disk of the planet. The centre of the circle marked 57 is placed on the circumference of the inner circle, by making its distance from the circle marked 59 answer to the interval of time between the two observations, properly calculated and reduced to sidereal measure. The same is done with regard to the circles marked 58, 59, &c.;" and it will be found by placing any one of these connected circles in such a manner as to have its contents in a similar situation with the figures

157 Dr Herschel's account of these spots.

gures in the single representation, which bears the same number, that there is a sufficient resemblance between them; though some allowance must undoubtedly be made for the distortions occasioned by this kind of projection.

158 Causes of the appearance and disappearance of these spots.

With regard to the bright spots themselves, Dr Herschel informs us, that the poles of the planets are not exactly in the middle of them, though nearly so. "From the appearance and disappearance (says he) of the bright north polar spot in the year 1781, we collect that the circle of its motion was at some considerable distance from the pole. By calculation, its latitude must have been about 76 or 77° north; for I find that, to the inhabitants of Mars, the declination of the sun, June 25th, 12 h. 15 m. of our time was about $9^\circ\ 56'$ south; and the spot must have been so far removed from the north pole as to fall a few degrees within the enlightened part of the disk to become visible to us. The south pole of Mars could not be many degrees from the centre of the large bright southern spot of the year 1781; though this spot was of such a magnitude as to cover all the polar regions farther than the 70th or 65th degree; and in that part which was on the meridian, July 3d, at 10 h. 54 minutes, perhaps a little farther.

"From the appearances of the south polar spot in 1781, we may conclude that its centre was nearly polar. We find it continued visible all the time Mars revolved on his axis; and to present us generally with a pretty equal share of the luminous appearance, a spot which covered from 45° to 60° of a great circle on the globe of the planet, could not have any considerable polar distance. From the observations and calculations made concerning the poles of Mars, we may conclude, that his north pole must be directed towards some point of the heavens, between $9^s\ 24^\circ\ 35'$ and $0^s\ 7^\circ\ 15'$; because the change of the situation of the pole from left to right, which happened in the time the planet passed from one place to the other, is a plain indication of its having gone through the node of its axis. Next, we may also conclude, that the node must be considerably nearer the latter point of the ecliptic than the former; for, whatever be the inclination of the axis, it will be seen under equal angles at equal distances from the node. But by a trigonometrical process of solving a few triangles, we soon discovered both the inclination of the axis, and the place where it intersects the ecliptic at rectangles (which, for want of a better term, I have perhaps improperly called its *node*.) Accordingly I find by calculation, that the node is in $17^\circ\ 47'$ of Pisces, the north pole of Mars being directed towards that part of the heavens; and that the inclination of the axis to the ecliptic is $59^\circ\ 40'$. By further calculations we find that the pole of Mars on the 17th of April 1777, was then actually $81^\circ\ 27'$ inclined to the ecliptic, and pointed towards the left as seen from the sun.

159 Of the exact position of the poles of Mars.

"The inclination and situation of the node of the axis of Mars, with respect to the ecliptic, being found, may be thus reduced to the orbit of the planet himself. Let EC (fig. 66.) be a part of the ecliptic, OM part of the orbit of Mars, PEO a line drawn from P, the celestial pole of Mars, through E, that point which has been determined to be the place of the node of the axis of Mars in the ecliptic, and continued to O, where it intersects his orbit. Now, if, according to M. de la Lande, we put the node of the orbit of Mars for 1783 in $1^s\ 17^\circ\ 58'$, we have from the place of the node of the axis, that is, $11^s\ 17^\circ\ 47'$ to the place of the node of the orbit, an arch EN of $60^\circ\ 11'$. In the triangle NEO, right-angled at E, there is also given the angle ENO, according to the same author, $1^\circ\ 51'$, which is the inclination of the orbit of Mars to the ecliptic. Hence we find the angle EON $89^\circ\ 5'$, and the side ON $60^\circ\ 12'$. Again, when Mars is in the node of its orbit N, we have by calculation the angle PNE$=63^\circ\ 7'$; to which adding the angle ENO$=1^\circ\ 51'$, we have PNO$=64^\circ\ 58'$: from which two angles, PON and PNO, with the distance ON, we obtain the inclination of the axis of Mars, and place of its node with respect to its own orbit; the inclination being $61^\circ\ 18'$, and the place of the node of the axis $58^\circ\ 31'$ preceding the intersection of the ecliptic with the orbit of Mars, or in our $19^\circ\ 28'$ of Pisces."

160 Of the seasons in Mars.

Our author next proceeds to show how the seasons in this planet may be calculated, &c. Which conjectures, though they belong properly to the next section, yet are so much connected with what has gone before, that we shall insert here what he says upon the subject.

"Being thus acquainted with what the inhabitants of Mars will call the obliquity of their ecliptic, and the situation of their equinoctial and solstitial points, we are furnished with the means of calculating the seasons on that planet, and may account, in a manner which I think highly probable, for the remarkable appearance about its polar regions.

"But first, it may not be improper to give an instance how to resolve any query concerning the Martial seasons. Thus, let it be required to compute the declination of the sun on Mars, June 25. 1781, at midnight of our time. If ♈, ♉, ♊, ♋, &c. (fig. 67.) represent the ecliptic of Mars, and ♈ ♋ ♎ ♑ the ecliptic of our planet, A*a*, *b*B the mutual intersection of the Martial and terrestrial ecliptics, then there is given the heliocentric longitude of Mars, ♈ *m* $= 9^s\ 10^\circ\ 30'$; then taking away six signs, and ♎ *b* or ♈ *a* $= 1^s\ 17^\circ\ 58'$, there remains *b m* $= 1^s\ 22^\circ\ 32'$. From this arch, with the given inclination $1^\circ\ 51'$ of the orbits to each other, we have cosine of inclination to radius, as tangent of *bm* to tangent of BM $= 1^s\ 22^\circ\ 33'$. And taking away B ♈ $= 1^s\ 1^\circ\ 29'$, which is the complement to ♑ B (or ♋ A, already shown to be $1^s\ 28^\circ\ 31'$), there will remain ♈ M $= 0^s\ 21^\circ\ 4'$, the place of Mars in its own orbit; that is, on the time above mentioned, the sun's longitude on Mars will be $6^s\ 21^\circ\ 4'$; and the obliquity of the Martial ecliptic, $28^\circ\ 42'$, being also given, we find, by the usual method, the sun's declination $9^\circ\ 56'$ south.

161 Considerable resemblance betwixt the earth and Mars.

"The analogy between Mars and the earth is perhaps by far the greatest in the whole solar system. Their diurnal motion is nearly the same; the obliquity of their respective ecliptics not very different: of all the superior planets, the distance of Mars from the sun is by far the nearest alike to that of the earth; nor will the length of the Martial year appear very different

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different from what we enjoy, when compared to the surprising duration of the years of Jupiter, Saturn, and the Georgium Sidus. If then we find that the globe we inhabit has its polar region frozen and covered with mountains of ice and snow that only partly melt when alternately exposed to the sun, I may well be permitted to surmise, that the same causes may probably have the same effect on the globe of Mars; that the bright polar spots are owing to the vivid reflection of light from frozen regions; and that the reduction of those spots is to be ascribed to their being exposed to the sun. In the year 1781, the south polar spot was extremely large, which we might well expect, as that pole had but lately been involved in a whole twelvemonth's darkness and absence of the sun; but in 1783, I found it considerably smaller than before, and it decreased continually from the 20th of May till about the middle of September, when it seemed to be at a stand. During this last period the south pole had already been above eight months enjoying the benefit of summer, and still continued to receive the sun-beams, though, towards the latter end, in such an oblique direction as to be but little benefited by them. On the other hand, in the year 1781, the north polar spot, which had then been its twelvemonth in the sunshine, and was but lately returning into darkness, appeared small, though undoubtedly increasing in size. Its not being visible in the year 1783, is no objection to these phenomena, being owing to the position of the axis, by which it was removed out of sight.

162 White spots about the poles of Mars, supposed to be occasioned by snow.

163 Of the spheroidical form of Mars.

"That a planetary globe, such as Mars, turning on an axis, should be of a spheroidical form, will easily find admittance, when two familiar instances in Jupiter and the earth, as well as the known laws of gravitation and the centrifugal force of rotatory bodies, lead the way to the reception of such doctrines. So far from creating difficulties, or doubts, it will rather appear singular, that the spheroidical form of this planet has not already been noticed by former astronomers; and yet, reflecting on the general appearance of Mars, we soon find, that opportunities of making observations on its real form cannot be very frequent: for when it is near enough to view it to an advantage, we see it generally gibbous, and its appositions are so scarce, and of so short a duration, that in more than two years time, we have not above three or four weeks for such observations. Besides, astronomers being generally accustomed to see this planet distorted, the spheroidical form might easily be overlooked.

164 Difference betwixt the equatorial and polar diameters of Mars.

"September 25. 1783. At 9h. 50 m. the equatorial diameter of Mars measured 21″ 53‴; the polar diameter 21″ 15‴, *full measure;* that is, certainly not too small. This difference of the diameters was shown, on the 28th of the same month, to Mr Wilson of Glasgow, who saw it perfectly well, so as to be convinced that it was not owing to any defect or distortion occasioned by the lens; and because I wished him to be satisfied of the reality of the appearance, I reminded him of several precautions; such as causing the planet to pass directly through the centre of the field of view, and judging of its figure when it was most distinct and best defined, &c. Next day the difference between the two diameters was shown to Dr Blagden and Mr Aubert. The former not only saw it immediately, but thought the flattening almost as much as that of Jupiter. Mr Aubert also saw it very plainly, so as to entertain no manner of doubt about the appearance.

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"September 30th, 10 h. 52 m. the equatorial diameter was 22″ 9‴, with a magnifying power of 278. By a second measure it was 22″ 31‴, full large; the polar diameter, very exact, was 21″ 26‴. On the first of October, at 10h. 50m. the equatorial diameter measured 103 by the micrometer, and the polar 98; the value of the divisions in seconds and thirds not being well determined, on account of some changes lately made in the focal length of the object metals of the telescope. On the 13th, the equatorial diameter was exactly 22″ 35‴: the polar diameter 21″ 35‴." In a great number of succeeding observations, the same appearance occurred; but on account of the quick changes in the appearance of this planet, Dr Herschel thought proper to settle the proportion betwixt the equatorial and polar diameters from those which were made on the very day of the apposition, and which were also to be preferred on account of their being repeated with a very high power, and in a fine clear air, with two different instruments of an excellent quality. From these he determined the proportions to be as 103 to 98, or 1355 to 1272.

165 Of the atmosphere of Mars.

It has been commonly related by astronomers, that the atmosphere of this planet is possessed of such strong refractive powers, as to render the small fixed stars near which its passes invisible. Dr Smith relates an observation of Cassini, where a star in the water of Aquarius, at the distance of six minutes from the disk of Mars, became so faint before its occultation, that it could not be seen by the naked eye, nor with a three feet telescope. This would indicate an atmosphere of a very extraordinary size and density: but the following observations of Dr Herschel seem to show that it is of much smaller dimensions. "1783, Oct. 26th. There are two small stars preceding Mars, of different sizes; with 460 they appear both dusky red, and are pretty unequal; with 218 they appear considerably unequal. The distance from Mars of the nearest, which is also the largest, with 227 measured 3′ 26″ 20‴. Some time after, the same evening, the distance was 3′ 8″ 55‴, Mars being retrograde. Both of them were seen very distinctly. They were viewed with a new 20 feet reflector, and appeared very bright. October 27th, the small star is not quite so bright in proportion to the large one as it was last night, being a good deal nearer to Mars, which is now on the side of the small star; but when the planet was drawn aside, or out of view, it appeared as plainly as usual. The distance of the small star was 2′ 5″ 25‴. The largest of the two stars (adds he), on which the above observations were made, cannot exceed the 12th, and the smallest the 13th or 14th magnitude; and I have no reason to suppose that they were any otherwise affected by the approach of Mars, than what the brightness of its superior light may account for. From other phenomena it appears, however, that this planet is not without a considerable atmosphere; for besides the permanent spots on its surface, I have often noticed occasional changes of partial bright belts, and also once a darkish one in a pretty high latitude; and these alterations we can hardly ascribe to any other cause than the variable disposition of clouds and vapours floating in the atmosphere of the planet."

Sect. IV. *Of Jupiter.*

Jupiter is the brightest of all the planets except Venus. He moves from west to east in a period of 4332.602208 days, exhibiting irregularities similar to those of Mars. Before he comes into opposition, and when distant from the sun about 115°, his motion becomes retrograde, and increases in swiftness till he comes into opposition. The motion then becomes gradually slower, and becomes direct when the planet advances within 115° of the sun. The duration of the retrograde motion is about 121 days, and the arch of retrogradation described is about 10°. But there is a considerable difference both in the amount and in the duration of this retrograde motion.

166 Belts of Jupiter when first discovered.

Jupiter has the same general appearance with Mars, only that the belts on his surface are much larger and more permanent. Their general appearance, as described by Dr Long, is represented fig. 68—71.; but they are not to be seen but by an excellent telescope. They are said to have been first discovered by Fontana and two other Italians; but Cassini was the first who gave a good account of them. Their number is very variable, as sometimes only one, and at others no fewer than eight, may be perceived. They are generally parallel to one another, but not always so; and their breadth is likewise variable, one belt having been observed to grow narrow, while another in its neighbourhood has increased in breadth, as if the one had flowed into the other: and in this case Dr Long observes, that a part of an oblique belt lay between them, as if to form a communication for this purpose. The time of their continuance is very uncertain, sometimes remaining unchanged for three months; at others, new belts have been formed in an hour or two.

167 Spots sometimes appear in them.

In some of these belts large black spots have appeared, which moved swiftly over the disk from east to west, and returned in a short time to the same place; from whence the rotation of this planet about its axis has been determined. On the 9th of May 1664, Dr Hook, with a good 12 feet telescope, observed a small spot in the biggest of the three obscure belts of Jupiter; and observing it from time to time, found that in two hours it had moved from east to west about half the visible diameter of the planet. In 1665, Cassini observed a spot near the largest belt of Jupiter which is most frequently seen. It appeared round, and moved with the greatest velocity when in the middle, but appeared narrower, and moved slower, the nearer it was to the circumference. "These circumstances (says Dr Long) showed that the spot adhered to the body of Jupiter, and was carried round upon it. It continued thereon till the year following; long enough to determine the periodical time of Jupiter's rotation upon his axis to be 9 h. 56 m."

168 Account of one of these spots.

This principal, or ancient spot as it is called, is the largest, and of the longest continuance of any hitherto known, and has appeared and vanished no fewer than eight times between the years 1665 and 1708; from the year last mentioned it was invisible till 1713. The longest time of its continuing to be visible was three years; and the longest time of its disappearing was from 1708 to 1713: it seems to have some connection with the principal southern belt; for the spot has never been seen when that disappeared, though that belt has often been visible without the spot. Besides this ancient spot, Cassini, in the year 1699, saw one of less stability that did not continue of the same shape or dimensions, but broke into several small ones, whereof the revolution was but 9 h. 51 m.; and two other spots that revolved in 9 h. $52\frac{1}{2}$ m. The figure of Jupiter is evidently an oblate spheroid, the longest diameter of his disk being to the shortest as 13 to 12. His rotation is from west to east, like that of the sun, and the plane of his equator is very nearly coincident with that of his orbit; so that there can scarce be any difference of seasons in that planet.

169 No difference of seasons in Jupiter.

His rotation has been observed to be somewhat quicker in his aphelion than his perihelion. The axis of rotation is nearly perpendicular to the plane of the ecliptic, and the planet makes one revolution in 0.41377 day, or about 9 h. 55′ and 37″. The changes in the appearance of these spots, and the difference in the time of their rotation, make it probable that they do not adhere to Jupiter, but are clouds transported by the winds with different velocities in an atmosphere subject to violent agitations.

The apparent diameter of this planet, is a maximum during his opposition to the sun, it is then equal to about 46″; when in conjunction it is smaller, being only about 31″: his mean apparent diameter is equal to 36″.

170 Is attended by four moons.

Four little stars are observed around Jupiter, which constantly accompany him. Their relative situation is continually changing. They oscillate on both sides of the planet, and their relative rank is determined by the length of these oscillations. That one in which the oscillation is shortest is called the *first satellite*, and so on. These satellites are analogous to our moon. See fig. 18. and 186. They are all supposed to move in ellipses; though the eccentricities of all of them are too small to be measured, excepting that of the fourth; and even this amounts to no more than 0.007 of its mean distance from the primary. The orbits of these planets were thought by Galileo to be in the same plane with that of their primary: but Mr Cassini has found that their orbits make a small angle with it; and as he did not find any difference in the place of their nodes, he concluded that they were all in the same place, and that their ascending nodes were in the middle of Aquarius. After observing them for more than 36 years, he found their greatest latitude, or deviation from the plane of Jupiter's orbit, to be 2° 55′.

171 Distances and periodical times of Jupiter's moons.

The first of these satellites revolves at the distance of 5.697 of Jupiter's semidiameters, or 1′ 51″ as measured by proper instruments; its periodical time is 1d. 18h. 27′ 34″. The next satellite revolves at the distance of 9.017 semidiameters, or 2′ 56″, in 3 d. 13 h. 13′ 43″; the third at the distance of 14.384 semidiameters, or 4′ 42″, in 7 d. 3 h. 42′ 36″; and the fourth at the distance of 25.266, or 8′ 16″, in 16 d. 16 h. 32′ 09″.

Since the time of Cassini it has been found that the nodes of Jupiter's satellites are not in the same place; and from the different points of view in which we have an opportunity of observing them from the earth, we see them sometimes apparently moving in straight lines, and at other times in elliptic curves. All of them, by reason of their immense distance, seem to keep near their primary, and their apparent motion is a kind of oscillation like that of a pendulum, going alternately

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ly from their greatest distance on one side to the greatest distance on the other, sometimes in a straight line, and sometimes in an elliptic curve. When a satellite is in its superior semicircle, or that half of its orbit which is more distant from the earth than Jupiter is, its motion appears to us direct, according to the order of the signs; but in its inferior semicircle, when it is nearer to us than Jupiter, its motion appears retrograde; and both these motions seem quicker the nearer the satellites are to the centre of the primary, slower the more distant they are, and at the greatest distance of all they appear for a short time to be stationary.

172 Occultations and eclipses of Jupiter's satellites.

From this account of the system of Jupiter and his satellites, it is evident, that occultations of them must frequently happen by their going behind their primary, or by coming in betwixt us and it. The former takes place when they proceed towards the middle of their upper semicircle; the latter, when they pass through the same part of their inferior semicircle. Occultations of the former kind happen to the first and second satellite; at every revolution, the third very rarely escapes an occultation, but the fourth more frequently by reason of its greater distance. It is seldom that a satellite can be discovered upon the disk of Jupiter, even by the best telescopes, excepting at its first entrance, when by reason of its being more directly illuminated by the rays of the sun than the planet itself, it appears like a lucid spot upon it.

173 The satellites sometimes appear as dark spots.

Sometimes, however, a satellite in passing over the disk, appears like a dark spot, and is easily to be distinguished. This is supposed to be owing to spots on the body of these secondary planets; and it is remarkable, that the same satellite has been known to pass over the disk at one time as a dark spot, and at another so luminous that it could not be distinguished from Jupiter himself, except at its coming on and going off. To account for this, we must say, that either the spots are subject to change; or if they be permanent like those of our moon, that the satellites at different times turn different parts of their globes towards us.

174 Why they vary in their light and apparent magnitude.

Possibly both these causes may contribute to produce the phenomena just mentioned. For these reasons also both the light and apparent magnitude of the satellites are variable; for the fewer spots there are upon that side which is turned towards us, the brighter it will appear; and as the bright side only can be seen, a satellite must appear larger the more of its bright side it turns towards the earth, and the less so the more it happens to be covered with spots. The fourth satellite, though generally the smallest, sometimes appears bigger than any of the rest: the third sometimes seems least, though usually the largest; nay, a satellite may be so covered with spots as to appear less than its shadow passing over the disk of the primary, though we are certain that the shadow must be smaller than the body which casts it. To a spectator placed on the surface of Jupiter, each of these satellites would put on the phases of the moon; but as the distance of any of them from Jupiter is but small when compared with the distance of that planet from the sun, the satellites are therefore illuminated by the sun very nearly in the same manner with the primary itself; hence they appear to us always round, having constantly the greatest part of their enlightened half turned towards the earth: and indeed they are so small, that were they to put on the phases of the moon, these phases could scarce be discerned through the best telescopes.

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175 Their shadows sometimes visible on the disk of Jupiter.

When the satellites pass through their inferior semicircles, they may cast a shadow upon their primary, and thus cause an eclipse of the sun to his inhabitants if there are any; and in some situations this shadow may be observed going before or following the satellite. On the other hand, in passing through their superior semicircles, the satellites may be eclipsed in the same manner as our moon by passing through the shadow of Jupiter:

176 Three of Jupiter's moons eclipsed in every revolution.

and this is actually the case with the first, second, and third of these bodies; but the fourth, by reason of the largeness of its orbit, passes sometimes above or below the shadow, as is the case with our moon.

177 At what time the eclipses, occultations, &c. of Jupiter's satellites are visible.

The beginnings and endings of these eclipses are easily seen by a telescope when the earth is in a proper situation with regard to Jupiter and the sun; but when this or any other planet is in conjunction with the sun, the superior brightness of that luminary renders both it and the satellites invisible. From the time of its first appearing after a conjunction until near the apposition, only the immersions of the satellites into his shadow, or the beginnings of the eclipses, are visible; at the apposition, only the occultations of the satellites, by going behind or coming before their primary, are observable; and from the apposition to the conjunction, only the immersions, or end of the eclipses, are to be seen. This is exactly true in the first satellite, of which we can never see an immersion with its immediately subsequent emersion: and it is but rarely that they can be both seen in the second; as in order to their being so, that satellite must be near one of its limits, at the same time that the planet is near his perihelion and quadrature with the sun. With regard to the third, when Jupiter is more than 46 degrees from conjunction with, or apposition to, the sun, both its immersions and immediately subsequent emersions are visible; as they likewise are in the fourth, when the distance of Jupiter from conjunction or apposition is 24 degrees.

When Jupiter is in quadrature with the sun, the earth is farthest out of the line that passes through the centres of the sun and Jupiter, and therefore the shadow of the planet is then most exposed to our view: but even then the body of the planet will hide from us one side of that part of the shadow which is nearest to it, through which the first satellite passes; which is the reason that though we see the entrance of that satellite into the shadow, or its coming out from thence, as the earth is situated on the east or west side thereof, we cannot see them both; whereas the other satellites going through the shadow at a greater distance from Jupiter, their ingress and egress are both visible.

Sect. V. *Of Saturn.*

Saturn is likewise a very conspicuous planet, though not so brilliant as Jupiter. The period of his sidereal revolution round the earth, is 10759.077213 days. He moves from west to east nearly in the plane of the ecliptic, and exhibits irregularities similar to those of Jupiter and Mars. He becomes retrograde both before and after his opposition, when at the distance of about 109° from the sun. His retrograde motion continues about 139 days, and during its continuance he describes an

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an arc of about 6°. His diameter is a maximum at his opposition, and his mean apparent diameter is 18″.

178 Telescopic appearance of Saturn.

Saturn, when viewed through a good telescope, makes a more remarkable appearance than any of the other planets. Galileo first discovered his uncommon shape, which he thought to be like two small globes, one on each side of a large one: and he published his discovery in a Latin sentence: the meaning of which was, that he had seen him appear with three bodies; though, in order to keep the discovery a secret, the letters were transposed. Having viewed him for two years, he was surprised to see him become quite round without these appendages, and then after some time to assume them as before.

179 His ring first discovered by Huygens.

These adjoining globes were what are now called the *ansæ* of his ring, the true shape of which was first discovered by Huygens about 40 years after Galileo, first with a telescope of 12 feet, and then with one of 23 feet, which magnified objects 100 times. From the discoveries made by him and other astronomers, it appears that this planet is surrounded by a broad thin ring, the edge of which reflects little or none of the sun's light to us, but the planes of the ring reflect the light in the same manner that the planet itself does; and if we suppose the diameter of Saturn to be divided into three equal parts, the diameter of the ring is about seven of these parts. The ring is detached from the body of Saturn in such a manner, that the distance between the innermost part of the ring and the body is equal to its breadth. If we had a view of the planet and his ring, with our eyes, perpendicular to one of the planes of the latter, we should see them as in fig. 72.: but our eye is never so much elevated above either plane as to have the visual ray stand at right angles to it, nor indeed is it ever elevated more than about 30 degrees above it; so that the ring, being commonly viewed at an oblique angle, appears of an oval form, and through very good telescopes double, as represented fig. 73. and 74. Both the outward and inward rim is projected into an ellipsis, more or less oblong according to the different degrees of obliquity with which it is viewed. Sometimes our eye is in the plane of the ring, and then it becomes invisible; either because the outward edge is not fitted to reflect the sun's light, or more probably because it is too thin to be seen at such a distance. As the plane of this ring keeps always parallel to itself, that is, its situation in one part of the orbit is always parallel to that in any other part, it disappears twice in every revolution of the planet, that is, about once in 15 years; and he sometimes appears quite round for nine months together. At other times, the distance betwixt the body of the planet and the ring is very perceptible; insomuch that Mr Whiston tells us of Dr Clarke's father having seen a star through the opening, and supposed him to have been the only person who ever saw a sight so rare, as the opening, though certainly very large, appears very small to us. When Saturn appears round, if our eye be in the plane of the ring, it will appear as a dark line across the middle of the planet's disk; and if our eye be elevated above the plane of the ring, a shadowy belt will be visible, caused by the shadow of the ring as well as by the interposition of part of it betwixt the eye and the planet. The shadow of the ring is broadest when the sun is most elevated, but its obscure parts appear broadest when our eye is most elevated above the plane of it. When it appears double, the ring next the body of the planet appears brightest; when the ring appears of an elliptical form, the parts about the ends of the largest axis are called the *ansæ*, as has been already mentioned. These, a little before and after the disappearing of the ring, are of unequal magnitude: the largest ansa is longer visible before the planet's round phase, and appears again sooner than the other. On the first of October 1714, the largest ansa was on the east side, and on the 12th on the west side of the disk of the planet, which makes it probable that the ring has a rotation round an axis.

180 Ring of Saturn probably has a revolution on its axis.

Herschel has demonstrated, that it revolves in its own plane in 10 hours 32′ 15.4″. The observations of this philosopher have added greatly to our knowledge of Saturn's ring. According to him there is one single, dark, considerably broad line, belt, or zone, which he has constantly found on the north side of the ring. As this dark belt is subject to no change whatever, it is probably owing to some permanent construction of the surface of the ring: this construction cannot be owing to the shadow of a chain of mountains, since it is visible all round on the ring; for there could be no shade at the ends of the ring: a similar argument will apply against the opinion of very extended caverns. It is pretty evident that this dark zone is contained between two concentric circles; for all the phenomena correspond with the projection of such a zone. The nature of the ring Dr Herschel thinks no less solid than that of Saturn itself, and it is observed to cast a strong shadow upon the planet. The light of the ring is also generally brighter than that of the planet; for the ring appears sufficiently bright when the telescope affords scarcely light enough for Saturn. The doctor concludes that the edge of the ring is not flat, but spherical or spheroidical. The dimensions of the ring, or of the two rings with the space between them, Dr Herschel gives as below:

	Miles.
Inner diameter of smaller ring	146345
Outside diam. of ditto	184393
Inner diam. of larger ring	190248
Outside diam. of ditto	204883
Breadth of the inner ring	20000
Breadth of the outer ring	7200
Breadth of the vacant space, or dark zone	2839

There have been various conjectures relative to the nature of this ring. Some persons have imagined that the diameter of the planet Saturn was once equal to the present diameter of the outer ring, and that it was hollow; the present body being contained within the former surface, in like manner as a kernel is contained within its shell: they suppose that, in consequence of some concussion, or other cause, the outer shell all fell down to the inner body, and left only the ring at the greater distance from the centre, as we now perceive it. This conjecture is in some measure corroborated by the consideration, that both the planet and its ring perform their rotations about the same common axis, and in very nearly the same time. But from the observations of Dr Herschel, he thus concludes: "It does not appear to me that there is sufficient ground for admitting the ring of Saturn to be of a very changeable nature, and I guess that its phenomena will hereafter be so fully explained, as to

reconcile

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reconcile all obſervations. In the meanwhile we muſt withhold a final judgment of its conſtruction, till we can have more obſervations. Its diviſion, however, into two very unequal parts, can admit of no doubt."

The diameters of Saturn are not equal: that which is perpendicular to the plane of his ring appears leſs by one-eleventh than the diameter ſituated in that plane. If we compare this form with that of Jupiter, we have reaſon to conclude that Saturn turns rapidly round his ſhorter axis, and that the ring moves in the plane of his equator. Herſchel has confirmed this opinion by actual obſervation. He has aſcertained the duration of a revolution of Saturn round his axis to amount to 0.428 day. Huygens obſerved five belts upon this planet nearly parallel to the equator.

181 His ſeven ſatellites.

Saturn is ſtill better attended than Jupiter (ſee fig. 18. and 186.); having, beſides the ring above-mentioned, no fewer than ſeven moons continually circulating round him. The firſt, at the diſtance of 2.097 ſemidiameters of his ring, and 4.893 of the planet itſelf, performs its revolution in 1 d. 21 h. 18′ 57″; the ſecond, at 2.686 ſemidiameters of the ring, and 6.268 of Saturn, revolves in 2 d. 17 h. 41′ 22″; the third, at the diſtance of 8.754 ſemidiameters of Saturn, and 3.752 of the ring, in 4 d. 12 h. 25′ 12″; the fourth, called the *Huygenian ſatellite*, at 8.698 ſemidiameters of the ring, and 20.295 of Saturn, revolves in 15 d. 22 h. 41′ 12″; while the fifth, placed at the vaſt diſtance of 59.154 ſemidiameters of Saturn, or 25.348 of his ring, does not perform its revolution in leſs than 79 d. 7 h. 47′ 00″. The orbits of all theſe ſatellites, except the fifth, are nearly in the ſame plane, which makes an angle with the plane of Saturn's orbit of about 31°; and by reaſon of their being inclined at ſuch large angles, they cannot paſs either acroſs their primary or behind it with reſpect to the earth, except when very near their nodes; ſo that eclipſes of them happen much more ſeldom than of the ſatellites of Jupiter. There is, however, an account in the Philoſ. Tranſact. of an occultation of the fourth ſatellite behind the body of Saturn; and there is a curious account by Caſſini in the Memoirs of the Royal Academy for 1692, of a fixed ſtar being covered by the fourth ſatellite, ſo that for 13 minutes they appeared both as one ſtar. By

182 Fifth ſatellite ſometimes diſappears, and why.

reaſon of their extreme ſmallneſs, theſe ſatellites cannot be ſeen unleſs the air be very clear; and Dom. Caſſini for ſeveral years obſerved the fifth ſatellite to grow leſs and leſs as it went through the eaſtern part of its orbit until it became quite inviſible; while in the weſtern part it gradually became more and more bright until it arrived at its greateſt ſplendor.—"This phenomenon (ſays Dr Long) cannot be better accounted for than by ſuppoſing one half the ſurface of this ſatellite to be unfit to reflect the light of the ſun in ſufficient quantity to make it viſible, and that it turns round its axis nearly in the ſame time as it revolves round its primary; and that, by means of this rotation, and keeping always the ſame face toward Saturn, we upon the earth may, during one half of its periodical time, be able to ſee ſucceſſively more and more of its bright ſide, and during the other half of its period have more and more of the ſpotted or dark ſide turned towards us. In the year 1705, this ſatellite unexpectedly became viſible in all parts of its orbit through the very ſame

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telescopes that were before often made uſe of to view it in the eaſtern part without ſucceſs: this ſhows the ſpots upon this ſatellite, like thoſe upon Jupiter and ſome other of the primary planets, are not permanent, but ſubject to change."

The two other ſatellites were diſcovered by Dr Herſchel in 1787 and 1788. They are nearer to Saturn than any of the other five. But in order to prevent confuſion, they have been called the 6th and 7th ſatellites. The fifth ſatellite has been obſerved by Dr Herſchel to turn once round its axis, exactly in the time in which it revolves round Saturn. In this reſpect it reſembles our moon.

Sect. VI. *Of Herſchel.*

The planets hitherto deſcribed have been known from the remoteſt antiquity; but the planet Herſchel, called alſo the Georgium Sidus, and Uranus, eſcaped the attention of the ancient aſtronomers. Flamſtead, Mayer, and Le Mounier had obſerved it as a ſmall ſtar; but in 1781 Dr Herſchel diſcovered its motion, and aſcertained it to be a planet. Like Mars, Jupiter, and Saturn, it moves from weſt to eaſt round the ſun. The duration of its ſidereal revolution is 30689 days. Its motion, which is nearly in the plane of the ecliptic, begins to be retrograde before and after the oppoſition, when the planet is 103.5° from the ſun; its retrograde motion continues for about 151 days; and the arc of retrogradation amounts to 3.6°. If we judge of the diſtance of this planet by the ſlowneſs of its motions, it ought to be at the very confines of the planetary ſyſtem.

183 Its ſatellites.

The apparent magnitude of this planet is ſo ſmall that it can ſeldom be ſeen with the naked eye. It is accompanied by ſix ſatellites: two of them, which were diſcovered by Dr Herſchel in 1787, revolve about that planet in periods of 8 d. 17 h. 1 m. 19 ſec. and 13 d. 11. h. 5 m. 1½ ſec. reſpectively, the angular diſtances from the primary being 33″ and 44⅔″: their orbits are nearly perpendicular to the plane of the ecliptic. The hiſtory of the diſcovery of the other four, with ſuch elements as could then be aſcertained, are given in the Philoſophical Tranſactions for 1798, Part I. The preciſe periods of theſe additional ſatellites cannot be aſcertained without a greater number of obſervations than had been made when Dr Herſchel ſent the account of their diſcovery to the Royal Society; but he gave the following eſtimates as the moſt probable which could be formed by means of the data then determined. Admitting the diſtance of the interior ſatellite to be 25″.5, its periodical revolution will be 5 d. 21 h. 25 m. If the intermediate ſatellite be placed at an equal diſtance between the two old ſatellites, or at 38″.57, its period will be 10 d. 23 h. 4 m. The neareſt exterior ſatellite is about double the diſtance of the fartheſt old one; its periodical time will therefore be about 38 d. 1 h. 49 m. The moſt diſtant ſatellite is full four times as far from the planet as the old ſecond ſatellite; it will therefore take at leaſt 107 d. 16 h. 40 m. to complete one revolution. All theſe ſatellites perform their revolutions in their orbits contrary to the order of the ſigns; that is, their real motion is retrograde.

Sect.

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SECT. VII. *Of Ceres and Pallas.*

THESE two planets, lately discovered by Piazzi and Olbers, two foreign astronomers, ought to have followed Mars in the order of description, as their orbits are placed between those of Mars and Jupiter; but as they have been observed only for a very short time, we judged it more proper to reserve the account of them till we came to the words CERES and PALLAS, when the elements of their orbits will in all probability be determined with more precision than at present. They are invisible to the naked eye; and Dr Herschel has ascertained that their size is extremely small. For that reason, together with the great obliquity of their orbits, he has proposed to distinguish them from the planets, and to call them *asteroids*.

CHAP. IV. *Of the Comets.*

THE planets are not the only moving bodies visible in the heavens. There are others which appear at uncertain intervals, and with a very different aspect from the planets. These are very numerous, and no fewer than 450 are supposed to belong to our solar system. They are called *Comets*, from their having a long tail, somewhat resembling the appearance of hair. This, however, is not always the case; for some comets have appeared which were as well defined, and as round as planets: but in general they have a luminous matter diffused around them, or projecting out from them, which to appearance very much resembles the Aurora Borealis. When these appear, they come in a direct line towards the sun, as if they were going to fall into his body; and after having disappeared for some time in consequence of their proximity to that luminary, they fly off again on the other side as fast as they came, projecting a tail much greater and brighter in their recess from him than when they advanced towards him; but, getting daily at a farther distance from us in the heavens, they continually lose of their splendour, and at last totally disappear. Their apparent magnitude is very different; sometimes they appear only of the bigness of the fixed stars; at other times they will equal the diameter of Venus, and sometimes even of the sun or moon. So, in 1652, Hevelius observed a comet which seemed not inferior to the moon in size, though it had not so bright a splendour, but appeared with a pale and dim light, and had a dismal aspect. These bodies will also sometimes lose their splendour suddenly, while their apparent bulk remains unaltered. With respect to their apparent motions, they have all the inequalities of the planets; sometimes seeming to go forwards, sometimes backwards, and sometimes to be stationary.

The comets, viewed through a telescope, have a very different appearance from any of the planets. The nucleus, or star, seems much more dim. Sturmius tells us, that observing the comet of 1680 with a telescope, it appeared like a coal dimly glowing; or a rude mass of matter illuminated with a dusky fumid light, less sensible at the extremes than in the middle; and not at all like a star, which appears with a round disk and a vivid light.

Hevelius observed of the comet in 1661, that its body was of a yellowish colour, bright and conspicuous, but without any glittering light. In the middle was a dense ruddy nucleus, almost equal to Jupiter, encompassed with a much fainter thinner matter.—February 5th. The nucleus was somewhat bigger and brighter, of a gold colour, but its light more dusky than the rest of the stars; it appeared also divided into a number of parts.—Feb. 6th. The nuclei still appeared, though less than before. One of them on the left side of the lower part of the disk appeared to be much denser and brighter than the rest; its body round, and representing a little lucid star; the nuclei still encompassed with another kind of matter.—Feb. 10th. The nuclei more obscure and confused, but brighter at top than at bottom.—Feb. 13th. The head diminished much both in brightness and in magnitude.—March 2d. Its roundness a little impaired, and the edges lacerated.—March 28th. Its matter much dispersed; and no distinct nucleus at all appearing.

Wiegelius, who saw through a telescope the comet of 1664, the moon, and a little cloud illuminated by the sun, at the same time, observed that the moon appeared of a continued luminous surface, but the comet very different, being perfectly like the little cloud enlightened by the sun's beams.

184 Atmospheres and phases of comets.

The comets, too, are to appearance surrounded with atmospheres of a prodigious size, often rising ten times higher than the nucleus. They have often likewise different phases, like the moon.

185 Dr Long's account of them.

"The head of a comet (says Dr Long) to the eye, unassisted by glasses, appears sometimes like a cloudy star; sometimes shines with a dull light like that of the planet Saturn: some comets have been said to equal, some to exceed, stars of the first magnitude; some to have surpassed Jupiter, and even Venus; and to have cast a shadow as Venus sometimes does.

"The head of a comet, seen through a good telescope, appears to consist of a solid globe, and an atmosphere that surrounds it. The solid part is frequently called the *nucleus*; which through a telescope is easily distinguished from the atmosphere or hairy appearance.

"A comet is generally attended with a blaze or tail, whereby it is distinguished from a star or planet; as it is also by its motion. Sometimes the tail only of a comet has been visible at a place where the head has been all the while under the horizon; such an appearance is called a *beam*.

186 Appearances of the comet of 1618.

"The nucleus of the comet of 1618 is said, a few days after coming into view, to have broken into three or four parts of irregular figures. One observer compares them to so many burning coals; and says they changed their situation while he was looking at them, as when a person stirs a fire; and a few days after were broken into a great number of smaller pieces. Another account of the same is, that on the 1st and 4th of December, the nucleus appeared to be a round, solid, and luminous body, of a dusky lead colour, larger than any star of the first magnitude. On the 8th of the same month it was broken into three or four parts of irregular figures; and on the 20th was changed into a cluster of small stars.

187 Phenomena of their tails.

"As the tail of a comet is owing to the heat of the sun, it grows larger as the comet approaches near to, and

and ſhortens as it recedes from, that luminary. If the tail of a comet were to continue of the ſame length, it would appear longer or ſhorter according to the different views of the ſpectator; for if his eye be in a line drawn through the middle of the tail lengthwiſe, or nearly ſo, the tail will not be diſtinguiſhed from the reſt of the atmoſphere, but the whole will appear round; if the eye be a little out of that line, the tail will appear ſhort as in fig. 75.; and it is called a *bearded comet* when the tail hangs down towards the horizon, as in that figure. If the tail of a comet be viewed ſidewiſe, the whole length of it is ſeen. It is obvious to remark, that the nearer the eye is to the tail, the greater will be the apparent length thereof.

"The tails of comets often appear bent, as in fig. 76. and 77. owing to the reſiſtance of the æther; which, though extremely ſmall, may have a ſenſible effect on ſo thin a vapour as the tails conſiſt of. This bending is ſeen only when the earth is not in the plane of the orbit of the comet continued. When that plane paſſes through the eye of the ſpectator, the tail appears ſtraight, as in fig. 78, 79.

"Longomontanus mentions a comet, that, in 1618, Dec. 10th, had a tail above 100 degrees in length; which ſhows that it muſt then have been very near the earth. The tail of a comet will at the ſame time appear of different lengths in different places, according as the air in one place is clearer than in another. It need not be mentioned, that in the ſame place, the difference in the eyes of the ſpectators will be the cauſe of their diſagreeing in their eſtimate of the length of the tail of a comet.

188 Difference between the obſervations of Hevelius and Hooke.

"Hevelius is very particular in telling us, that he obſerved the comet of 1665 to caſt a ſhadow upon the tail; for in the middle thereof there appeared a dark line. It is ſomewhat ſurpriſing, that Hooke ſhould be poſitive in affirming, on the contrary, that the place where the ſhadow of the comet ſhould have been, if there had been any ſhadow, was brighter than any other part of the tail. He was of opinion that comets have ſome light of their own: His obſervations were made in a hurry; he owns they were ſhort and tranſitory. Hevelius's were made with ſo much care, that there is more reaſon to depend upon them. Dom. Caſſini obſerved, in the tail of the comet of 1680, a darkneſs in the middle; and the like was taken notice of by a curious obſerver in that of 1744.

189 Account of the comet of 1680.

"There are three comets, viz. of 1680, 1744, and 1759, that deſerve to have a farther account given of them. The comet of 1680 was remarkable for its near approach to the ſun; ſo near, that in its perihelion it was not above a ſixth part of the diameter of that luminary from the ſurface thereof. Fig. 77. taken from Newton's Principia, repreſents ſo much of the trajectory of this comet as it paſſed through while it was viſible to the inhabitants of our earth, in going from and returning to its perihelion. It ſhows alſo the tail, as it appeared on the days mentioned in the figure. The tail, like that of other comets, increaſed in length and brightneſs as it came nearer to the ſun; and grew ſhorter and fainter as it went farther from him and from the earth, till that and the comet were too far off to be any longer viſible.

"The comet of 1744 was firſt ſeen at Lauſanne in Switzerland, Dec. 13. 1743, N. S. From that time it increaſed in brightneſs and magnitude as it was coming nearer to the ſun. The diameter of it, when at the diſtance of the ſun from us, meaſured about one minute; which brings it out equal to three times the diameter of the earth. It came ſo near Mercury, that, if its attraction had been proportionable to its magnitude, it was thought probable it would have diſturbed the motion of that planet. Mr Betts of Oxford, however, from ſome obſervations made there, and at Lord Macclesfield's obſervatory at Sherburn, found, that when the comet was at its leaſt diſtance from Mercury, and almoſt twice as near the ſun as that planet was, it was ſtill diſtant from him a fifth part of the diſtance of the ſun from the earth; and could therefore have no effect upon the planet's motions. He judged the comet to be at leaſt equal in magnitude to the earth. He ſays, that in the evening of Jan. 23d, this comet appeared exceedingly diſtinct and bright, and the diameter of its nucleus nearly equal to that of Jupiter. Its tail extended above 16 degrees from its body; and was in length, ſuppoſing the ſun's parallax 10″, no leſs than 23 millions of miles. Dr Bevis, in the month of May 1744, made four obſervations of Mercury, and found the places of that planet, calculated from correct tables, differed ſo little from the places obſerved, as to ſhow that the comet had no influence upon Mercury's motion.

190 Of that of 1744.

"The nucleus, which had before been always round, on the 10th of February appeared oblong in the direction of the tail, and ſeemed divided into two parts, by a black ſtroke in the middle. One of the parts had a ſort of beard brighter than the tail; this beard was ſurrounded by two unequal dark ſtrokes, that ſeparated the beard from the hair of the comet. The odd phenomena diſappeared the next day, and nothing was ſeen but irregular obſcure ſpaces like ſmoke in the middle of the tail; and the head reſumed its natural form. February 15th, the tail was divided into two branches; the eaſtern part about ſeven or eight degrees long, the weſtern 24. On the 23d, the tail began to be bent; it ſhowed no tail till it was as near to the ſun as the orbit of Mars; the tail grew longer as it approached nearer the ſun; and at its greateſt length was computed to equal a third part of the diſtance of the earth from the ſun. Fig. 76. is a view of this comet, taken by an obſerver at Cambridge. I remember that, in viewing it, I thought the tail ſeemed to ſparkle, or vibrate luminous particles. Hevelius mentions the like in other comets; and that their tails lengthen and ſhorten while we are viewing. This is probably owing to the motion of our air.

191 Of the comet of 1759.

"The comet of 1759 did not make any conſiderable appearance by reaſon of the unfavourable ſituation of the earth all the time its tail might otherwiſe have been conſpicuous; the comet being then too near the ſun to be ſeen by us; but deſerves our particular conſideration, as it was the firſt that ever had its return foretold."

Hevelius gives pictures of comets of various ſhapes; as they are deſcribed by hiſtorians to have been like a ſword, a buckler, a tun, &c. Theſe are drawn by fancy only, from the deſcription in words. He gives, however, alſo pictures of ſome comets, engraved by his

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his own hand from the views he had of them through a very long and excellent teleſcope. In theſe we find changes in the nucleus and the atmoſphere of the ſame comet. The nucleus of the comet of 1661, which in one obſervation appeared as one round body, as it is repreſented in fig. 87. in ſubſequent views ſeemed to conſiſt of ſeveral ſmaller ones ſeparated from one another, as in fig. 86. The atmoſphere ſurrounding the nucleus, at different times, varied in the extent thereof; as did alſo the tail in length and breadth. The nuclei of other comets, as has already been obſerved, have ſometimes phaſes like the moon. Thoſe of 1744 and 1769 had both this kind of appearance. See fig. 34.

Chap. V. *Of the fixed Stars.*

192 Number of fixed ſtars increaſed by teleſcopes.

The parallax of the ſtars is inſenſible. When viewed through the beſt teleſcopes, they appear not at all magnified, but rather diminiſhed in bulk; by reaſon, as is thought by ſome, that the teleſcope takes off that twinkling appearance they make to the naked eye; but by others, more probably, that the teleſcope tube excludes a quantity of the rays of light, which are not only emitted from the particular ſtars themſelves, but by many thouſands more, which falling upon our eyelids and the aerial particles about us, are reflected into our eyes ſo ſtrongly as to excite vibrations, not only on thoſe points of the retina where the images of the ſtars are formed, but alſo in other points at the ſame diſtance round about. This without the teleſcope makes us imagine the ſtars to be much bigger than when we ſee them only by a few rays coming directly from them, ſo as to enter our eyes without being intermixed with others. The ſmallneſs of their apparent diameter is proved by the ſuddenneſs with which they diſappear on their occultations by the moon. The time which they take does not amount to one ſecond, which ſhows their apparent diameter not to exceed 4″. The vivacity of their light, compared with their ſmall diameter, leads us to ſuppoſe them at a much greater diſtance than the planets, and to conſider them as luminous bodies like our ſun, inſtead of borrowing their light from that luminary like the planets.

193 Different magnitudes of the ſtars.

The ſtars, on account of their apparently various magnitudes, have been diſtributed into ſeveral claſſes or orders. Thoſe which appear largeſt are called *ſtars of the firſt magnitude;* the next to them in luſtre, *ſtars of the ſecond magnitude;* and ſo on to the *ſixth*, which are the ſmalleſt that are viſible to the bare eye. This diſtribution having been made long before the invention of teleſcopes, the ſtars which cannot be ſeen without the aſſiſtance of theſe inſtruments are diſtinguiſhed by the names of *teleſcopic ſtars*.

194 Teleſcopic ſtars.

195 Unformed ſtars.

The ancients divided the ſtarry ſphere into particular conſtellations, or ſyſtems of ſtars, according as they lay near one another, ſo as to occupy thoſe ſpaces which the figures of different ſorts of animals or things would take up, if they were there delineated. And thoſe ſtars which could not be brought into any particular conſtellation were called *unformed ſtars*.

196 Uſes of their diviſion into conſtellations.

This diviſion of the ſtars into different conſtellations, or aſteriſms, ſerves to diſtinguiſh them from one another, ſo that any particular ſtar may be readily found in the heavens by means of a celeſtial globe; on which the conſtellations are ſo delineated, as to put the moſt remarkable ſtars into ſuch parts of the figures as are moſt eaſily diſtinguiſhed. The number of the ancient conſtellations is 48, and upon our preſent globes about 70. On Senex's globes are inſerted Bayer's letters; the firſt in the Greek alphabet being put to the biggeſt ſtar in each conſtellation, the ſecond to the next, and ſo on: by which means, every ſtar is as eaſily found as if a name were given to it. Thus, if the ſtar γ in the conſtellation of the Ram be mentioned, every aſtronomer knows as well what ſtar is meant as if it were pointed out to him in the heavens. See fig. 205, 206, where the ſtars are repreſented with the figures of the animals from whence the conſtellations are marked.

197 Diviſion of the heavens. Fig. 26, 29.

There is alſo a diviſion of the heavens into three parts. 1. The zodiac (ζωδιακος), from ζωδιον, *zodion*, "an animal," becauſe moſt of the conſtellations in it, which are 12 in number, have the names of animals; As *Aries* the ram, *Taurus* the bull, *Gemini* the twins, *Cancer* the crab, *Leo* the lion, *Virgo* the virgin, *Libra* the balance, *Scorpio* the ſcorpion, *Sagittarius* the archer, *Capricornus* the goat, *Aquarius* the water-bearer, and *Piſces* the fiſhes. The zodiac goes quite round the heavens: it is about 16 degrees broad, ſo that it takes in the orbits of all the planets, and likewiſe the orbit of the moon. Along the middle of this zone or belt is the ecliptic, or circle which the earth deſcribes annually as ſeen from the ſun, and which the ſun appears to deſcribe as ſeen from the earth. 2. All that region of the heavens which is on the north ſide of the zodiac, containing 21 conſtellations. And, 3. That on the ſouth ſide, containing 15.

198 Zodiac how divided.

The ancients divided the zodiac into the above 12 conſtellations or ſigns in the following manner: They took a veſſel with a ſmall hole in the bottom, and, having filled it with water, ſuffered the ſame to diſtil drop by drop into another veſſel ſet beneath to receive it; beginning at the moment when ſome ſtar roſe, and continuing till it roſe the next following night. The water falling down into the receiver they divided into 12 equal parts; and having two other ſmall veſſels in readineſs, each of them fit to contain one part, they again poured all the water into the upper veſſel; and, obſerving the riſing of ſome ſtar in the zodiac, they at the ſame time ſuffered the water to drop into one of the ſmall veſſels; and as ſoon as it was full, they ſhifted it, and ſet an empty one in its place. When each veſſel was full, they took notice what ſtar of the zodiac roſe; and though this could not be done in one night, yet in many they obſerved the riſing of 12 ſtars or points, by which they divided the zodiac into 12 parts.

The names of the conſtellations, and the number of ſtars obſerved in each of them by different aſtronomers are as follow.

The Ancient Constellations.

199 Catalogue of the constellations.

		Ptolemy.	Tycho.	Hevelius.	Flamstead.
Ursa minor	The Little Bear	8	7	12	24
Ursa major	The Great Bear	35	29	73	87
Draco	The Dragon	31	32	40	80
Cepheus	Cepheus	13	4	51	35
Bootes, *Arctophilax*		23	18	52	54
Corona Borealis	The Northern Crown	8	8	8	21
Hercules, *Engonasin*	Hercules kneeling	29	28	45	113
Lyra	The Harp	10	11	17	21
Cygnus, *Gallina*	The Swan	10	18	47	81
Cassiopeia	The Lady in her chair	13	26	37	55
Perseus	Perseus	29	29	46	59
Auriga	The Waggoner	14	9	40	66
Serpentarius, *Opiuchus*	Serpentarius	29	15	40	74
Serpens	The Serpent	18	13	22	64
Sagitta	The Arrow	5	5	5	18
Aquila, *Vultur*	The Eagle }	15	12	23	71
Antinous	Antinous }		3	19	
Delphinus	The Dolphin	10	10	14	18
Equulus, *Equi sectio*	The Horse's Head	4	4	6	10
Pegasus, *Equus*	The Flying Horse	20	19	38	89
Andromeda	Andromeda	23	23	47	66
Triangulum	The Triangle	4	4	12	16
Aries	The Ram	18	21	27	66
Taurus	The Bull	44	43	51	141
Gemini	The Twins	25	25	38	85
Cancer	The Crab	23	15	29	83
Leo	The Lion }	35	30	49	95
Coma Berenices	Berenice's Hair }		14	21	43
Virgo	The Virgin	32	33	50	110
Libra, *Chelæ*	The Scales	17	10	20	51
Scorpio	The Scorpion	24	10	20	44
Sagittarius	The Archer	31	14	22	69
Capricornus	The Goat	28	28	29	51
Aquarius	The Water-bearer	45	41	47	108
Pisces	The Fishes	38	36	39	113
Cetus	The Whale	22	21	45	97
Orion	Orion	38	42	62	78
Eridanus, *Fluvius*	Eridanus, *the River*	34	10	27	84
Lepus	The Hare	12	13	16	19
Canis major	The Great Dog	29	13	21	31
Canis minor	The Little Dog	2	2	13	14
Argo Navis	The Ship	45	3	4	64
Hydra	The Hydra	27	19	31	60
Crater	The Cup	7	3	10	31
Corvus	The Crow	7	4		9
Centaurus	The Centaur	37			35
Lupus	The Wolf	19			24
Ara	The Altar	7			9
Corona Australis	The Southern Crown	13			12
Piscis Australis	The Southern Fish	18			24

The new Southern Constellations.

Columba Noachi	Noah's Dove	10	Apis, *Musca*	The Bee or Fly	4
Robur Carolinum	The royal Oak	12	Chamæleon	The Chameleon	10
Grus	The Crane	13	Triangulum Australe	The South Triangle	5
Phœnix	The Phenix	13	Piscis volans, *Passer*	The Flying Fish	8
Indus	The Indian	12	Dorado, *Xiphias*	The Sword Fish	6
Pavo	The Peacock	14	Toucan	The American Goose	9
Apus, *Avis Indica.*	The Bird of Paradise	11	Hydrus	The Water Snake	10

Hevelius's Conſtellations made out of the unformed Stars.

		Hevel.	Flamſt.
Lynx	The Lynx	19	44
Leo minor	The Little Lion		53
Aſterion & Chara	The Greyhounds	23	25
Cerberus	Cerberus	4	
Vulpecula & Anſer	The Fox and Gooſe	27	35
Scutum Sobieſki	Sobieſki's Shield	7	
Lacerta	The Lizard	10	16
Camelopardalus	The Camelopard	32	58
Monoceros	The Unicorn	19	31
Sextans	The Sextant	11	41

Several ſtars obſerved by the ancients are now no more to be ſeen, but are deſtroyed; and new ones have appeared which were unknown to the ancients. Some of them have alſo diſappeared for ſome time, and again become viſible.

We are alſo aſſured from the obſervations of aſtronomers, that ſome ſtars have been obſerved which never were ſeen before, and for a certain time they have diſtinguiſhed themſelves by their ſuperlative luſtre; but afterwards decreaſing, they vaniſhed by degrees, and were no more to be ſeen. One of theſe ſtars being firſt ſeen and obſerved by Hipparchus, the chief of the ancient aſtronomers, ſet him upon compoſing a catalogue of the fixed ſtars, that by it poſterity might learn whether any of the ſtars periſh, and others are produced afreſh.

After ſeveral ages, another new ſtar appeared to Tycho Brahe and the aſtronomers who were cotemporary with him; which put him on the ſame deſign with Hipparchus, namely, the making a catalogue of the fixed ſtars. Of this, and other ſtars which have appeared ſince that time, we have the following hiſtory

200 Dr Halley's hiſtory of new ſtars.

by Dr Halley: "The firſt new ſtar in the chair of Caſſiopeia, was not ſeen by Cornelius Gemma on the 8th of November 1572, who ſays, he that night conſidered that part of the heaven in a very ſerene ſky, and ſaw it not: but that the next night, November 9. it appeared with a ſplendor ſurpaſſing all the fixed ſtars, and ſcarce leſs bright than Venus. This was not ſeen by Tycho Brahe before the 11th of the ſame month: but from thence he aſſures us that it gradually decreaſed and died away, ſo as in March 1574, after ſixteen months, to be no longer viſible; and at this day no ſigns of it remain. The place thereof in the ſphere of fixed ſtars, by the accurate obſervations of the ſame Tycho, was $0^s\ 9^\circ\ 17'$ *a* 1^{ma} * ♈^{is}, with $53^\circ\ 45'$ north latitude.

"Such another ſtar was ſeen and obſerved by the ſcholars of Kepler, to begin to appear on Sept. 30. *ſt. vet.* anno 1604, which was not to be ſeen the day before: but it broke out at once with a luſtre ſurpaſſing that of Jupiter; and like the former, it died away gradually, and in much about the ſame time diſappeared totally, there remaining no footſteps thereof in January $160\frac{5}{6}$. This was near the ecliptic, following the right leg of Serpentarius; and by the obſervations of Kepler and others, was in 7 ſec. $20^\circ\ 00'$ *a* 1^{ma} * ♈, with north latitude $1^\circ\ 56'$. Theſe two ſeem to be of a diſtinct ſpecies from the reſt, and nothing like them has appeared ſince.

"But between them, viz. in the year 1596, we have the firſt account of the wonderful ſtar in Collo Ceti, ſeen by David Fabricius on the third of Auguſt, *ſt. vet.* as bright as a ſtar of the 3d magnitude, which has been ſince found to appear and diſappear periodically; its period being preciſely enough ſeven revolutions in ſix years, though it returns not always with the ſame luſtre. Nor is it ever totally extinguiſhed, but may at all times be ſeen with a ſix feet tube. This was ſingular in its kind, till that in Collo Cygni was diſcovered. It precedes the firſt ſtar of Aries $1^\circ\ 40'$, with $15^\circ\ 57'$ ſouth latitude.

"Another new ſtar was firſt diſcovered by William Janſonius in the year 1600, *in pectore*, or rather *in eductione*, Colli Cygni, which exceeded not the third magnitude. This having continued ſome years, became at length ſo ſmall, as to be thought by ſome to have diſappeared entirely: but in the years 1657, 1658, and 1659, it again aroſe to the third magnitude; though ſoon after it decayed by degrees to the fifth or ſixth magnitude, and at this day is to be ſeen as ſuch in $9^s\ 18^\circ\ 38'$ *a* 1^{ma} * ♈, with $55^\circ\ 29'$ north latitude.

"A fifth new ſtar was firſt ſeen by Hevelius in the year 1670, on July 15. *ſt. vet.* as a ſtar of the third magnitude, but by the beginning of October was ſcarce to be perceived by the naked eye. In April following it was again as bright as before, or rather greater than of the third magnitude, yet wholly diſappeared about the middle of Auguſt. The next year, in March 1672, it was ſeen again, but not exceeding the ſixth magnitude: ſince when, it has been no further viſible, though we have frequently ſought for its return; its place is $9^s\ 3^\circ\ 17'$ *a* 1^{ma} * ♈, and has lat. north $47^\circ\ 28'$.

"The ſixth and laſt is that diſcovered by Mr G. Kirch in the year 1686, and its period determined to be of $404\frac{1}{2}$ days; and though it rarely exceeds the fifth magnitude, yet it is very regular in its returns, as we found in the year 1714. Since then we have watched, as the abſence of the moon and clearneſs of the weather would permit, to catch the firſt beginning of its appearance in a ſix feet tube, that, bearing a very great aperture, diſcovers moſt minute ſtars. And on June 15. laſt, it was firſt perceived like one of the very leaſt teleſcopical ſtars: but in the reſt of that month and July, it gradually increaſed, ſo as to become in Auguſt viſible to the naked eye: and ſo continued till the month of September. After that, it again died away by degrees: and on the 8th of December, at night, was ſcarce diſcernible by the tube; and, as near as could be gueſſed, equal to what it was at its firſt appearance on June 25th: ſo that this year it has been ſeen in all near ſix months, which is but little leſs than half its period; and the middle, and conſequently the greateſt brightneſs, falls about the 10th of September."

201 Mr Montanere's account of changes amongſt the fixed ſtars.

Concerning the changes which happen among the fixed ſtars, Mr Montanere, profeſſor of mathematics at Bononia, gave the following account, in a letter to the Royal Society, dated April 30th 1670. "There are not wanting in the heavens two ſtars of the ſecond magnitude in the ſtern of the ſhip Argo, and its yard; Bayerus marked them with the letters β and χ. I and others obſerved them in the year 1664, upon the occaſion of the comet that appeared that year: when they diſappeared firſt, I know not: only I am ſure that in the year 1668, upon the 10th of April, there was not the leaſt glimpſe of them to be ſeen; and yet the

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rest about them, even of the third and fourth magnitudes, remained the same. I have observed many more changes among the fixed stars, even to the number of a hundred, though none of them are so great as those I have showed."

The late improvements in astronomy, and particularly those in the construction of telescopes, have now given astronomers an opportunity of observing the changes which take place among the stars with much greater accuracy than could be formerly done. In a paper in the 76th volume of the Philosophical Transactions, Mr Edward Pigot gives a dissertation on the stars suspected by the astronomers of last century to be changeable. For the greater accuracy in the investigation of his subject, he divides them into two classes; one containing those which are undoubtedly changeable, and the other those which are only suspected to be so. The former contains a list of 12 stars, from the first to the fourth magnitudes; including the new one which appeared in Cassiopeia in 1572, and that in Serpentarius in 1604: the other contains the names of 38 stars of all magnitudes, from the first to the seventh. He is of opinion, that the celebrated new star in Cassiopeia is a periodical one, and that it returns once in 150 years. Mr Keill is of the same opinion: and Mr Pigot thinks, that its not being observed at the expiration of each period is no argument against the truth of that opinion; "since (says he), perhaps, as with most of the variables, it may at different periods have different degrees of lustre, so as sometimes only to increase to the ninth magnitude; and if this should be the case, its period is probably much shorter." For this reason, in September 1782, he took a plan of the small stars near the place where it formerly appeared, but in four years had observed no alteration.

202 Mr Pigot's remarks on the accounts of variable stars.

203 Star in Collo Ceti.

The star in the neck of the Whale had also been examined by Mr Pigot from the end of 1782 to 1786, but he never found it exceed the sixth magnitude; though Mr Goodricke had observed it on the 9th of August to be of the second magnitude, and on the 3d of September the same year it was of the third magnitude. Mr Pigot deduced its period from its apparent equality with a small star in the neighbourhood, and thence found it to be 320, 328, and 337 days.

204 Algol.

The most remarkable of these changeable stars is that called *Algol*, in the head of Medusa. It had long been known to be variable; but its period was first ascertained by Mr Goodricke of York, who began to observe it in the beginning of 1783. It changes continually from the first to the fourth magnitude; and the time taken up from its greatest diminution to its least is found, at a mean, to be 2 d. 20 h. 49 m. and 3 sec. During four hours it gradually diminishes in lustre, which it recovers during the succeeding four hours; and in the remaining part of the period it invariably preserves its greatest lustre, and after the expiration of the term its diminution again commences. According to Mr Pigot, the degree of brightness of this star when at its *minimum* is variable in different periods, and he is of the same opinion with regard to its brightness when at its full; but whether these differences return regularly or not, has not been determined.

The 420th of Mayer's catalogue, in Leo, has lately been shown to be variable by Mr Koch. Some years before 1782, that gentleman perceived it undoubtedly smaller than the 419th of the same catalogue. In February that year, it was of the same brightness with the 419th, that is, of the seventh magnitude. In April 1783, it was of the ninth magnitude; and in the same month 1784, it was of the tenth. Mr Pigot could never observe this star, though he frequently looked for it with a night-glass, and on the fifth of April 1785 with a three-feet achromatic transit instrument.

205 Variable star in Hydra.

In 1704, Maraldi observed a variable star in Hydra, whose period he settled at about two years, though with considerable variations: but from the observations even of Maraldi, Mr Pigot concludes, that its period was then only 494 days; and from some others made by himself, he thinks that now it is only 487 days; so that since the time of Maraldi it has shortened seven days. The particulars relating to this star are as follow. 1. When at its full brightness it is of the fourth magnitude, and does not perceptibly change for a fortnight. 2. It is about six months in increasing from the tenth magnitude and returning to the same: so that it may be considered as invisible during that time. 3. It is considerably more quick, perhaps one half more so, in its increase than in its decrease. 4. Though when at its full it may always be styled a star of the fourth magnitude, it does not constantly attain the same degree of brightness, but the differences are very small. This star is the 30th of Hydra in Hevelius's catalogue, and is marked by him of the sixth magnitude.

The new star in Serpentarius, observed by Kepler, seems to have been of the same nature with that of Cassiopeia; and Mr Pigot therefore looks upon it also to be a periodical one, though, after taking a plan of the nearest stars in that part of the heavens, in the year 1782, he could, in four years time, perceive no alteration.

The variation of the star β Lyræ was discovered by Mr Goodricke above mentioned, who suspects its period to be six days nine hours; which coincides with the opinion of Mr Pigot.

206 Swan's Head.

The new star near the Swan's Head, observed by Don Anthelme in December 1669, soon became of the third magnitude, and disappeared in 1672. Mr Pigot has constantly looked for it since November 1781, but without success. He is of opinion, that had it only increased to the 10th or 11th magnitude, he would have seen it, having taken a plan of all the neighbouring small stars.

The next variable star in Mr Pigot's catalogue is the η Antinoi, whose variation and period he discovered in 1785. From his corrected observations, he concludes that it continues at its greatest brightness 40 hours without decreasing; it is 66 hours after it begins to decrease before it comes to its full diminution; after which it continues stationary for 30 hours more, and then increases for 36 hours. In every period it seems to acquire its full brightness, and to be equally decreased.

207 Swan's Neck.

The variable star in the Swan's Neck was observed for three years. The period of this star had been settled by Maraldi and Cassini at 405, and by M. le Gentil at 405.3 days; but from a mean of the observations of Mr Pigot, it appears to be only 392.

"Perhaps

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" Perhaps (ſays he) its period is irregular; to determine which ſeveral intervals of 15 years ought to be taken; and I am much inclined to believe that it will be found only 396 days 21 hours." The particulars relating to this ſtar are, 1. When at its full brightneſs it undergoes no perceptible change for a fortnight. 2. It is about three months and a half in increaſing from the 11th magnitude to its full brightneſs, and the ſame in decreaſing; for which reaſon it may be conſidered as inviſible during ſix months. 3. It does not always attain the ſame degree of luſtre, being ſometimes of the fifth and ſometimes of the ſeventh magnitude.

208 Swan's Breaſt.

In 1600, G. Janſonius diſcovered a variable ſtar in the breaſt of the Swan, which was afterwards obſerved by different aſtronomers, and ſuppoſed to have a period of about 10 years. The reſults of Mr Pigot's calculations from the obſervations of former aſtronomers are, 1. That it continues in full luſtre for five years. 2. It decreaſes rapidly for two years. 3. It is inviſible to the naked eye for four years. 4. It increaſes ſlowly during ſeven years. 5. All theſe changes are completed in 18 years. 6. It was at its *minimum* at the end of the year 1663. 7. It does not always increaſe to the ſame degree of brightneſs, being ſometimes of the third, and at others only of the ſixth, magnitude. " I am entirely ignorant (ſays Mr Pigot) whether it is ſubject to the ſame changes in this century, having not met with any ſeries of obſervations on it; but if the above conjectures are right, it will be at its minimum in a very few years. Since November 1781 I have conſtantly ſeen it of the ſixth magnitude. Sometimes I have ſuſpected that it has decreaſed within theſe two laſt years, though in a very ſmall degree."

The laſt ſtar in Mr Pigot's firſt claſs is the δ Cephei, whoſe variation was diſcovered by Mr Goodricke. Its changes are very difficult to be ſeen, unleſs it is obſerved at the times of its greateſt and leaſt brightneſs. The reſult of the obſervations hitherto made upon it are, that its period conſiſts of 5 days 8 hours 37′ on a mean. The following obſervations relate to ſome ſtars of the ſecond claſs.

209 Stars, variation of, which is leſs certain.

1. Hevelius's 6th Caſſiopeiæ was miſſing in 1782, nor could Mr Pigot find it in 1783 and 1784.

2. ξ or 46th Andromedæ, ſaid to be variable, but the evidence is not convincing to Mr Pigot.

3. Flamſtead's 50, 52, τ Andromedæ, and Hevelius's 41 Andromedæ. The poſition and characters of theſe ſtars differ conſiderably in different catalogues, and ſome of them are ſaid by Caſſini to have diſappeared and re-appeared. Mr Pigot therefore gives their comparative brightneſs as obſerved in the years 1783, 1784, and 1785, during which time he does not mention any particular change.

4. Tycho's 20th Ceti. " This (ſays Mr Pigot) muſt be the ſtar which Hevelius ſaid had diſappeared, being Tycho's ſecond in the Whale's Belly. There can hardly be any doubt that it is the χ, miſplaced by Tycho. This χ is of the fourth or fifth magnitude.

5. σ, or the 17th Eridani of Ptolemy and Ulug Beigh. Flamſtead ſays he could not ſee this ſtar in 1691 and 1692: but in 1782, 1783, and 1784, Mr Pigot obſerved in that place one of the ſeventh magnitude, which appeared always of the ſame luſtre.

6. Flamſtead's 41 Tauri was ſuppoſed by Caſſini to be either a new or variable ſtar; but Mr Pigot thinks there is no reaſon to be of that opinion. " That it is not new (ſays he) is evident, ſince it is Ulug Beigh's 26th and Tycho's 43d.

7. A ſtar about $2\frac{1}{2}$ north of 53 Eridani, and 47 Eridani. Caſſini ſuppoſed the firſt of theſe ſtars to be a new one, and that it was not viſible in 1664. He mentions another ſtar thereabouts, which he alſo eſteemed a new one.

8. γ Canis Majoris. Maraldi could not ſee this ſtar in 1670; but in 1692 and 1693 it appeared of the fourth magnitude. Mr Pigot made frequent obſervations upon it from 1782 to 1786, but could perceive no variation.

9. α, β Geminorum. " If any of theſe ſtars (ſays our author) have changed in brightneſs, it is probably the β. In 1783, 1784, and 1785, the β was undoubtedly brighter than α."

10. ξ Leonis. According to Montanari, this ſtar was hardly viſible in 1693. In 1783, 1784, and 1785, it was of the fifth magnitude. By Tycho, Flamſtead, Mayer, Bradley, &c. it is marked of the fourth.

11. ψ Leonis. This ſtar is ſaid to have diſappeared before the year 1667; but according to Mr Pigot's obſervations, was conſtantly of the fifth or ſixth magnitude ſince 1783.

12. 25th Leonis. In 1783, our author firſt perceived that this ſtar was miſſing, and could not perceive it in 1784 and 1785, even with a tranſit inſtrument.

13. Bayer's ι Leonis, or Tycho's 16 Leonis, was not viſible in 1709, nor could it be ſeen in 1785. It is a different ſtar from the ι Leonis of the other catalogues, though Tycho's deſcription of its place is the ſame.

14. δ Urſæ Majoris. This ſtar is ſuſpected to change in brightneſs, on account of its being marked by Tycho, the prince of Heſſe, &c. of the ſecond magnitude, while Hevelius, Bradley, and others, have marked it of the third. In 1786, and for three years before, it appeared as a bright ſtar of the fourth magnitude.

15. η Virginis. This is ſuppoſed to be variable, becauſe Flamſtead, on the 27th of January 1680, could not ſee it; but he obſerved it in 1677, and ſome years afterwards. Mr Pigot obſerved it frequently in 1784 and 1785, and found it a ſtar of the ſixth magnitude without any perceptible change.

16. Bayer's ſtar of the ſixth magnitude 1° ſouth of *g* Virginis. " This ſtar (ſays Mr Pigot) is not in any of the nine Catalogues that I have. Maraldi looked for it in vain; and in May 1785 I could not ſee the leaſt appearance of it." It certainly was not of the eighth magnitude.

17. A ſtar in the northern thigh of Virgo, marked by Ricciolus of the ſixth magnitude, could not be ſeen by Maraldi in 1709; nor was it of the ninth magnitude, if at all viſible in 1785.

18. The 91 and 92 Virginis. In 1785, one of theſe ſtars, probably the 91, was miſſing: the remaining one is of the ſixth or ſeventh magnitude.

19. α Draconis. Mr Pigot coincides in opinion with Dr Herſchel, that this ſtar is variable. Bradley, Flamſtead, &c. mark it of the ſecond magnitude, but in 1786 it was only a bright fourth. It was frequently

examined by Mr Pigot from the 4th of October 1782, but without any alteration being perceived.

20. Bayer's ſtar in the weſt ſcale of Libra. Maraldi could not ſee this ſtar, and it was likewiſe inviſible to Mr Pigot in 1784 and 1785.

21. N° 6 of Ptolemy and Ulug Beigh's unformed in Libra. This ſtar is not mentioned in any other catalogues than the above. Mr Pigot frequently obſerved a little ſtar of the ſeventh magnitude very near its place.

22. κ Libræ. This ſtar is thought to be variable, but Mr Pigot is not of that opinion, though "certainly (ſays he) it is rather ſingular, that Hevelius, whoſe attention was directed to that part of the heavens to find Tycho's 11th, did not find the κ; and the more ſo, as he has noticed two much ſmaller ſtars not far from it. During theſe three years I have found the κ conſtantly of the fifth magnitude."

23. Tycho's 11th Libræ. Mr Pigot is of opinion that no ſuch ſtar as this ever exiſted; and that it is no other than the κ with an error of 2 degrees of longitude.

24. 33 Serpentis. This ſtar was miſſing in 1784; nor could it be perceived with a night-glaſs in 1785.

25. A ſtar marked by Bayer near ε Urſæ majoris. This ſtar could not be ſeen by Caſſini; nor was Mr Pigot able to diſcover it with a night-glaſs in 1782.

26. The ρ, or Ptolemy and Ulug Beigh's 14th Ophiuchi, or Flamſtead's 36th. Mr Pigot has no doubt that this is the ſtar which is ſaid to have diſappeared before the year 1695; and it is evident that it was not ſeen by Hevelius. In 1784 and 1785 Mr Pigot found it of the fourth or fifth magnitude; but he is far from being certain of its having undergone any change, eſpecially as it has a ſouthern declination of 26 degrees; for which reaſon great attention muſt be paid to the ſtate of the atmoſphere.

27. Ptolemy's 13th and 18th Ophiuchi, fourth magnitude. Mr Pigot is of opinion that theſe ſtars are miſplaced in the catalogues. The 18th of Ptolemy he thinks ought to be marked with a north latitude inſtead of a ſouth, which would make it agree nearly with Flamſtead's 58th; and he is alſo of opinion that the 13th of Ptolemy is the 40th of Flamſtead.

28. σ Sagittarii. Dr Herſchel, as well as Mr Pigot, is of opinion, that this ſtar has probably changed its magnitude, though the reaſon ſeems only to be the great diſagreement concerning it among the different catalogues of ſtars.

29. θ Serpentis. This ſtar, according to Mr Montanari, is of variable magnitude; but Mr Pigot never could perceive any alteration.

30. Tycho's 27th Capricorni was miſſing in Hevelius's time, and Mr Pigot could not find it with a tranſit inſtrument.

31. Tycho's 22d Andromedæ, and ο Andromedæ. Mr Caſſini informs us, that in his time the former had grown ſo ſmall that it could ſcarcely be ſeen; and Mr Pigot, that no ſtar was to be ſeen in its place in 1784 and 1785: but he is of opinion that Caſſini may have miſtaken the ο Andromedæ for the 22d; for which reaſon he obſerved this ſtar three years, but without any alteration in its brightneſs.

32. Tycho's 19th Aquarii. Hevelius ſays that this ſtar was miſſing, and that Flamſtead could not ſee it with his naked eye in 1679. Mr Pigot could not ſee it in 1782; but is perſuaded that it is the ſame with Flamſtead's 56th marked *f* by Bayer, from which it is only a degree and an half diſtant. The 53d of Flamſtead, marked *f* in Ptolemy's catalogue, is a different ſtar.

33. La Caille's 483 Aquarii was firſt diſcovered to be miſſing in 1778, and was not viſible in 1783 and 1784.

Beſides theſe there are ſeveral others certainly variable, but which cannot be ſeen in this country. There are ſome alſo ſuſpected to be variable, but for which Mr Pigot thinks there is no reaſon. Dr Herſchel alſo gives ſtrong reaſons for not laying great ſtreſs on all the obſervations by which new ſtars have been ſaid to be diſcovered. Mr Pigot aſſures us from repeated experience, that even more than a ſingle obſervation, if not particulariſed and compared with neighbouring ſtars, is very little to be depended upon; different ſtreaks of the clouds, the ſtate of the weather, &c. having often cauſed him to err a whole magnitude in the brightneſs of a ſtar.

210 Wollaſton's method of diſcovering variations among the fixed ſtars.

As theſe changes to which the fixed ſtars are liable do not ſeem to be ſubject to any certain rule, Mr Wollaſton has given an eaſy method of obſerving whether they do take place in any part of the heavens or not, and that without much expence of inſtruments or waſte of time, which are great objections to aſtronomical obſervations in general. His firſt idea was, that the work ſhould be undertaken by aſtronomers in general; each taking a particular diſtrict of the heavens, and from time to time obſerving the right aſcenſion and declination of every ſtar in that ſpace allotted to him, framing an exact map of it, and communicating their obſervations to one common place of information. This method, however, being too laborious, he next propoſes the noting down at the time, or making a drawing of what one ſees while they are obſerving. A drawing of this kind once made, would remain, and could be conſulted on any future occaſion; and if done at firſt with care, a tranſient review would diſcover whether any ſenſible change had taken place ſince it was laſt examined, which could not ſo well be done by catalogues or verbal deſcription. For this purpoſe he recommends the following method: "To a night-glaſs, but of Dollond's conſtruction, which magnifies about ſix times, and takes in about as many degrees of a great circle, I have added croſs wires interſecting one another at an angle of 45 degrees. More wires may be croſſed in other directions; but I apprehend theſe will be ſufficient. This teleſcope I mount on a polar axis. One coarſely made, and without any diviſions on its circle of declination, will anſwer the purpoſe, as there is no great occaſion for accuracy in that reſpect; but as the heavenly bodies are more readily followed by an equatorial motion of the teleſcope, ſo their relative poſitions are much more eaſily diſcerned when they are looked at conſtantly as in the ſame direction. A horizontal motion, except in the meridian, would be apt to miſlead the judgment. It is ſcarcely neceſſary to add, that the wires muſt ſtand ſo as for one to deſcribe a parallel of the equator nearly; another will then be a horary circle, and the whole area will be divided into eight equal ſectors.

"Thus prepared, the teleſcope is to be pointed to a known

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known ſtar, which is to be brought into the centre or common interſection of all the wires. The relative poſitions of ſuch other ſtars as appear within the field are to be judged of by the eye; whether at $\frac{1}{2}$, $\frac{1}{3}$, or $\frac{1}{4}$, from the centre towards the circumference, or *vice verſa*; and ſo with regard to the neareſt wire reſpectively. Theſe, as one ſees them, are to be noted down with a black-lead pencil upon a large meſſage-card held in the hand, upon which a circle ſimilarly divided is ready drawn. One of three inches diameter ſeems moſt convenient. The motion of the heavenly bodies in ſuch a teleſcope is ſo ſlow, and the noting down of the ſtars ſo quickly done, that there is commonly full time for it without moving the teleſcope. When that is wanted, the principal ſtar is eaſily brought back again into the centre of the field at pleaſure, and the work reſumed. After a little practice, it is aſtoniſhing how near one can come to the truth in this way: and though neither the right aſcenſions nor the declinations are laid down by it, nor the diſtances between the ſtars meaſured; yet their apparent ſituations being preſerved in black and white, with the day and year, and hour, if thought neceſſary, written underneath, each card then becomes a regiſter of the then appearance of the heavens; which is eaſily re-examined at any time with little more than a tranſient view; and which will yet ſhow, on the firſt glance, if there ſhould have happened in it any alteration of conſequence."

Fig. 80. ſhows part of the Corona Borealis delineated in this manner, and which was afterwards fully taken down by making the ſtars α, β, γ, δ, ε, ζ, θ, ι, $\varkappa$, π, ϱ, σ, and τ, ſucceſſively central; and theſe were joined with ſome of the ſtars of Bootes, for the ſake of connecting the whole, and united into one map, as repreſented fig. 81.

In obſerving in this way, it is evident, that the places of ſuch ſtars as happen to be under or very near any of the wires, are more to be depended upon than thoſe which are in the intermediate ſpaces, eſpecially if towards the edges of the fields; ſo alſo thoſe which are neareſt to the centre, becauſe better defined, and more within the reach of one wire or another. For this reaſon, different ſtars of the ſame ſet muſt ſucceſſively be made central, or brought towards one of the wires, where any ſuſpicion ariſes of a miſtake, in order to approach nearer to a certainty; but if the ſtand of the teleſcope be tolerably well adjuſted and fixed, this is ſoon done.

In ſuch a glaſs it is ſeldom that light ſufficient for diſcerning the wires is wanting. When an illuminator is required, a piece of card or white paſteboard projecting on one ſide beyond the tube, and which may be brought forward occaſionally, is better than any other. By cutting acroſs a ſmall ſegment of the object-glaſs, it throws a ſufficient light down the tube though the candle be at a great diſtance, and one may loſe ſight of the falſe glare by drawing back the head, and moving the eye a little to one ſide, when the ſmall ſtars will be ſeen as if no illuminator was there. See a delineation of the principal fixed ſtars, with the apparent path of the ſun among them, in figures 82 and 83.

211 Galaxy, or milky-way.

A very remarkable appearance in the heavens is that called the *galaxy*, or *milky-way*. This is a broad circle, ſometimes double, but for the moſt part ſingle, ſurrounding the whole celeſtial concave. We perceive alſo in different parts of the heavens ſmall white ſpots, which appear to be of the ſame nature with the milky-way. Theſe ſpots are called *nebulæ*.

We ſhall ſubjoin in this place, for the entertainment of the reader, the theories of Mr Michell and Dr Herſchel, concerning the nature and poſition of the fixed ſtars.

212 Mr Michell's conjectures concerning the nature of the fixed ſtars.

"The very great number of ſtars (ſays Mr Michell) that have been diſcovered to be double, triple, &c. particularly by Mr Herſchel, if we apply the doctrines of chances, as I have heretofore done in my inquiry into the probable parallax, &c. of the fixed ſtars, publiſhed in the Philoſophical Tranſactions for the year 1767, cannot leave a doubt with any one who is properly acquainted with the force of thoſe arguments, that by far the greateſt part, if not all of them, are ſyſtems of ſtars ſo near each other, as probably to be liable to be affected ſenſibly by their mutual gravitation; and it is therefore not unlikely, that the periods of the revolutions of ſome of theſe about their principals (the ſmaller ones being, upon this hypotheſis, to be conſidered as ſatellites to the other) may ſome time or other be diſcovered." Having then ſhown in what manner the magnitude of a fixed ſtar, if its denſity were known, would affect the velocity of its light, he concludes at laſt, that "if the ſemidiameter of a ſphere of the ſame denſity with the ſun were to exceed his in the proportion of 500 to 1, a body falling from an infinite height towards it (or moving in a parabolic curve at its ſurface) would have acquired a greater velocity than that of light; and conſequently, ſuppoſing light to be attracted by the ſame force in proportion to its *vis inertiæ* with other bodies, all light emitted from ſuch a body would be made to return towards it by its own proper gravity. But if the ſemidiameter of a ſphere, of the ſame denſity with the ſun, was of any other ſize leſs than 497 times that of the ſun, though the velocity of light emitted by ſuch a body would never be wholly deſtroyed, yet it would always ſuffer ſome diminution, more or leſs according to the magnitude of the ſphere. The ſame effects would likewiſe take place if the ſemidiameters were different from thoſe already mentioned, provided the denſity was greater or leſs in the duplicate ratio of theſe ſemidiameters inverſely.

213 In what caſes light may be ſuppoſed to return to the body that emits it.

214 Comparative brightneſs of the ſun and fixed ſtars.

After proceeding in his calculations, in order to find the diameter and diſtance of any ſtar, he proceeds thus: "According to Mr Bouguer the brightneſs of the ſun exceeds that of a wax candle in no leſs a proportion than that of 8000 to 1. If therefore the brightneſs of any of the fixed ſtars ſhould not exceed that of our common candles, which, as being ſomething leſs luminous than wax, we will ſuppoſe in round numbers to be only one ten thouſandth part as bright as the ſun, ſuch a ſtar would not be viſible at more than one hundredth part of the diſtance at which it would be ſeen if it were as bright as the ſun. Now, becauſe the ſun would ſtill, I apprehend, appear as bright and luminous as the ſtar Sirius, if removed to 400,000 times his preſent diſtance, ſuch a body, if no brighter than our common candles, would only appear equally luminous with that ſtar at 4000 times the diſtance of the ſun; and we might then be able, with the beſt teleſcopes, to diſtinguiſh ſome ſenſible ap-

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parent diameter of it: but the apparent diameters of the ſtars of leſſer magnitudes would ſtill be too ſmall to be diſtinguiſhable even with our beſt teleſcopes, unleſs they were yet a good deal leſs luminous; which may poſſibly, however, be the caſe with ſome of them: for though we have indeed very ſlight grounds to go upon with regard to the ſpecific brightneſs of the fixed ſtars, compared with that of the ſun at preſent, and can therefore form only very uncertain and random conjectures concerning it; yet from the infinite variety which we find in the works of the creation, it is not unreaſonable to ſuſpect, that very poſſibly ſome of the fixed ſtars may have ſo little natural brightneſs in proportion to their magnitude, as to admit of their diameters having ſome ſenſible apparent ſize when they ſhall come to be more carefully examined, and with larger and better teleſcopes than have been hitherto in common uſe.

215 Luminous appearance of the ſun ſuppoſed to proceed from an atmoſphere.

"With reſpect to the ſun, we know that his whole ſurface is extremely luminous, a very ſmall and temporary interruption ſometimes, from a few ſpots, excepted. This univerſal and exceſſive brightneſs of the whole ſurface is probably owing to an atmoſphere, which being luminous throughout, and in ſome meaſure alſo tranſparent, the light proceeding from a conſiderable depth of it, all arrives at the eye, in the ſame manner as the light of a great number of candles would do if they were placed one behind another, and their flames were ſufficiently tranſparent to permit the light of the more diſtant ones to paſs through thoſe that were nearer without interruption.

"How far the ſame conſtitution may take place in the fixed ſtars we do not know: probably, however, it may ſtill do ſo in many; but there are ſome appearances, with regard to a few of them, which ſeem to make it probable that it does not do ſo univerſally. Now, if I am right in ſuppoſing the light of the ſun to proceed from a luminous atmoſphere which muſt neceſſarily diffuſe itſelf equally over the whole ſurface, and I think there can be very little doubt that this is really the caſe, this conſtitution cannot well take place in thoſe ſtars which are in ſome degree periodically more and leſs luminous, ſuch as that in Collo Ceti,

216 Of the variable ſtars.

&c. It is alſo not very improbable, that there is ſome difference from that of the ſun in the conſtitution of thoſe ſtars which have ſometimes appeared and diſappeared, of which that in the conſtellation of Caſſiopeia is a notable inſtance. And if theſe conjectures are well founded which have been formed by ſome philoſophers concerning ſtars of this kind, that they are not wholly luminous, or at leaſt not conſtantly ſo, but that all, or by far the greateſt part of their ſurfaces, is ſubject to conſiderable changes, ſometimes becoming luminous, at other times extinguiſhed; it is amongſt ſtars of this ſort that we are moſt likely to meet with inſtances of a ſenſible apparent diameter, their light being much more likely not to be ſo great in proportion as that of the ſun, which if removed to 400,000 times his preſent diſtance, would ſtill appear, I apprehend, as bright as Sirius, as I have obſerved above; whereas it is hardly to be expected, with any teleſcope whatſoever, that we ſhould ever be able to diſtinguiſh a well-defined diſk of any body of the ſame ſize with the ſun at much more than 10,000 times his preſent diſtance.

"Hence the greateſt diſtance at which it would be poſſible to diſtinguiſh any ſenſible apparent diameter of a body as denſe as the ſun, cannot well greatly exceed five hundred times ten thouſand; that is, five million times the diſtance of the ſun; for if the diameter of ſuch a body was not leſs than 500 times that of the ſun, its light, as has been ſhown above, could never arrive at us."

Dr Herſchel, improving on Mr Michell's idea of the fixed ſtars being collected into groups, and aſſiſted by his own obſervations with the extraordinary teleſcopic powers already mentioned, has ſuggeſted a theory concerning the conſtruction of the univerſe entirely new and ſingular. It had been the opinion of former aſtronomers, that our ſun, beſides occupying the centre of the ſyſtem which properly belongs to him, occupied alſo the centre of the univerſe: but Dr Herſchel is of a very different opinion. "Hitherto (ſays he) the ſidereal heavens have, not inadequately for the purpoſe deſigned, been repreſented by the concave ſurface of a ſphere, in the centre of which the eye of the obſerver might be ſuppoſed to be placed. It is true, the various magnitudes of the fixed ſtars even then plainly ſuggeſted to us, and would have better ſuited, the idea of an expanded firmament of three dimenſions; but the obſervations upon which I am now going to enter, ſtill farther illuſtrate and enforce the neceſſity of conſidering the heavens in this point of view. In future therefore we ſhall look upon thoſe regions into which we may now penetrate by means of ſuch large teleſcopes (A), as a naturaliſt regards a rich extent of ground or chain of mountains, containing ſtrata variouſly inclined and directed, as well as conſiſting of very different materials. A ſurface of a globe or map therefore will but ill delineate the interior parts of the heavens." 217 Dr Herſchel's opinion concerning the conſtruction of the univerſe.

With the powerful teleſcope mentioned in the note, Dr Herſchel firſt began to ſurvey the Via Lactea, and found that it completely reſolved the whitiſh appearance into ſtars, which the teleſcopes he formerly uſed had not light enough to do. The portion he firſt obſerved was that about the hand and club of Orion; and found therein an aſtoniſhing multitude of ſtars, whoſe number he endeavoured to eſtimate by counting many fields (B), and computing from a mean of theſe how many might be contained in a given portion of the milky-way. In the moſt vacant place to be met with in that neighbourhood he found 63 ſtars; other ſix fields contained 110, 60, 70, 90, 70, and 74 ſtars; a mean of all which gave 79 for the number of ſtars to each field; and thus he found, that by allowing 15 minutes 218 His obſervations on the Via Lactea.

(A) Dr Herſchel's obſervations, on which this theory is founded, were made with a Newtonian reflector of 20 feet focal length, and an aperture of 18 inches.

(B) By this word we are to underſtand the apparent ſpace in the heavens he could ſee at once through his teleſcope.

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minutes for the diameter of his field of view, a belt of 15 degrees long and two broad, which he had often feen pafs before his telefcope in an hour's time, could not contain lefs than 50,000 ftars, large enough to be diftinctly numbered; befides which, he fufpected twice as many more, which could be feen only now and then by faint glimpfes for want of fufficient light.

219 On the nebulæ.

The fuccefs he had within the milky-way foon induced him to turn his telefcope to the nebulous parts of the heavens, of which an accurate lift had been publifhed in the *Connoiffance des Temps* for 1783 and 1784. Moft of thefe yielded to a Newtonian reflector of 20 feet focal diftance and 12 inches aperture; which plainly difcovered them to be compofed of ftars, or at leaft to contain ftars, and to fhow every other indication of confifting of them entirely. "The nebulæ (fays he) are arranged into ftrata, and run on to a great length; and fome of them I have been able to purfue, and to guefs pretty well at their form and direction. It is probable enough that they may furround the whole ftarry fphere of the heavens, not unlike the milky-way, which undoubtedly is nothing but a ftratum of fixed ftars: And as this latter immenfe ftarry bed is not of equal breadth or luftre in every part, nor runs on in one ftraight direction, but is curved, and even divided into two ftreams along a very confiderable portion of it; we may likewife expect the greateft variety in the ftrata of the clufters of ftars and nebulæ. One of thefe nebulous beds is fo rich, that, in paffing through a fection of it in the time of only 36 minutes, I have detected no lefs than 31 nebulæ, all diftinctly vifible upon a fine blue fky. Their fituation and fhape, as well as condition, feem to denote the greateft variety imaginable. In another ftratum, or perhaps a different branch of the former, I have often feen double and treble nebulæ varioufly arranged; large ones with fmall feeming attendants; narrow, but much extended lucid nebulæ or bright dafhes; fome of the fhape of a fan, refembling an electric brufh iffuing from a lucid point; others of the cometic fhape, with a feeming nucleus in the centre, or like cloudy ftars, furrounded with a nebulous atmofphere: a different fort again contain a nebulofity of the milky kind, like that wonderful inexplicable phenomenon about θ Orionis; while others fhine with a fainter mottled kind of light, which denotes their being refolvable into ftars.

220 They are arranged into ftrata.

221 Variety of fhapes affumed by them.

222 Why the milky-way appears to furround the heavens.

"It is very probable that the great ftratum called the *milky-way*, is that in which the fun is placed, though perhaps not in the very centre of its thicknefs. We gather this from the appearance of the galaxy, which feems to encompafs the whole heavens, as it certainly muft do if the fun is within the fame. For fuppofe a number of ftars arranged between two parallel planes, indefinitely extended every way, but at a given confiderable diftance from one another, and calling this a fidereal ftratum, an eye placed fomewhere within it will fee all the ftars in the direction of the planes of the ftratum projected into a great circle, which will appear lucid on account of the accumulation of the ftars, while the reft of the heavens at the fides will only feem to be fcattered over with conftellations, more or lefs crowded according to the diftance of the planes or number of ftars contained in the thicknefs or fides of the ftratum.

"Thus in fig. 83. an eye at S within the ftratum *a b*, will fee the ftars in the direction of its length *a b*, or height *e d*, with all thofe in the intermediate fituation, projected into the lucid circle ABCD; while thofe in the fides *m e*, *n w*, will be feen fcattered over the remaining part of the heavens at MVNW.

223 Celeftial appearances folved on Dr Herfchel's hypothefis.

"If the eye were placed fomewhere without the ftratum, at no very great diftance, the appearance of the ftars within it would affume the form of one of the leffer circles of the fphere, which would be more or lefs contracted to the diftance of the eye; and if this diftance were exceedingly increafed, the whole ftratum might at laft be drawn together into a lucid fpot of any fhape, according to the pofition, length, and height of the ftratum.

"Let us now fuppofe, that a branch or fmaller ftratum fhould run out from the former in a certain direction, and let it alfo be contained between two parallel planes extended indefinitely onwards, but fo that the eye may be placed in the great ftratum fomewhere before the feparation, and not far from the place where the ftrata are ftill united; then will this fecond ftratum not be projected into a bright circle like the former, but will be feen as a lucid branch proceeding from the firft, and returning to it again at a certain diftance lefs than a femicircle. Thus, in the fame figure, the ftars in the fmall ftratum *p g* will be projected into a bright arch at PRRP, which after its feparation from the circle CBD, unites with it again at P.

"What has been inftanced in parallel planes may eafily be applied to ftrata irregularly bounded, and running in various directions; for their projection will of confequence vary according to the quantities of the variations in the ftrata and the diftance of the eye from the fame. And thus any kind of curvatures, as well as various degrees of brightnefs, may be produced in the projections.

224 Of the fun's place in the univerfe.

"From appearances, then, as I obferved before, we may infer, that the fun is moft likely placed in one of the great ftrata of the fixed ftars, and very probably not far from the place where fome fmaller ftratum branches out from it. Such a fuppofition will fatisfactorily, and with great fimplicity, account for all the phenomena of the milky-way; which according to this hypothefis, is no other than the appearance of the projection of the ftars contained in this ftratum and its fecondary branch. As a farther inducement to look on the galaxy in this point of view, let it be confidered, that we can no longer doubt of its whitifh appearance arifing from the mixed luftre of the numberlefs ftars that compofe it. Now, fhould we fuppofe it to be an irregular ring of ftars, in the centre nearly of which we muft then fuppofe the fun to be placed, it will appear not a little extraordinary, that the fun, being a fixed ftar, like thofe which compofe this imagined ring, fhould juft be in the centre of fuch a multitude of celeftial bodies, without any apparent reafon for this fingular diftinction; whereas, on our fuppofition, every ftar in this ftratum, not very near the termination of its length or height, will be fo placed as alfo to have its own galaxy, with only fuch variations in the form and luftre of it as may arife from the particular fituation of each ftar.

225 Herfchel's method of gauging the heavens.

"Various methods may be taken to come to a knowledge of the fun's place in the fidereal ftratum, one

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one of which I have already begun to put in practice: I call it *gauging the heavens*; or the *ſtar-gauge*. It conſiſts in repeatedly taking the number of ſtars in ten fields of view of my reflector very near each other; and by adding their ſums, and cutting off one decimal on the right, a mean of the contents of the heavens in all the parts which are thus gauged are obtained. Thus it appears that the number of ſtars increaſes very much as we approach the milky-way; for in the parallel from 92 to 94 degrees north polar diſtance, and right aſcenſion 15 h. 10′, the ſtar-gauge runs up from 9.4 ſtars in the field to 18.6 in about an hour and a half; whereas in the parallel from 78 to 80 degrees north polar diſtance, and R. A. 11, 12, 13, and 14 hours, it very ſeldom riſes above 4. We are, however, to remember, that, with different inſtruments, the account of the gauges will be very different, eſpecially on our ſuppoſition of the ſun in a ſtratum of ſtars. For let *a b*, fig. 84. be the ſtratum, and ſuppoſe the ſmall circle *g h l k* to repreſent the ſpace into which, by the light and power of a given teleſcope, we are enabled to penetrate, and let GHLK be the extent of another portion which we are enabled to viſit by means of a larger aperture and power, it is evident, that the gauges with the latter inſtrument will differ very much in their account of ſtars contained at MN and at KG or LH, when with the former they will hardly be affected with the change from *m n* to *k g* or *l k*.

226 How to find the place of the ſun in the ſidereal ſtratum.

"The ſituation of the ſun in the ſidereal ſtratum will be found by conſidering in what manner the ſtar-gauge agrees with the length of a ray revolving in ſeveral directions about an aſſumed point, and cut off by the bounds of the ſtratum. Thus, in fig. 85. let S be the place of an obſerver: S r r r, *S r r r*, lines in the plane r S r, *r S r*, drawn from S within the ſtratum to one of the boundaries here repreſented by the plane AB. Then, ſince neither the ſituation of S nor the form of the limiting ſurface AB is known, we are to aſſume a point, and apply to it lines proportional to the ſeveral gauges that have been obtained, and at ſuch angles from each other as they may point out: then will the termination of theſe lines delineate the boundary of the ſtratum, and conſequently manifeſt the ſituation of the ſun within the ſame.

227 Obſervations on nebulæ.

"In my late obſervations on nebulæ, I ſoon found, that I generally detected them in certain directions rather than in others: that the ſpaces preceding them were generally quite deprived of their ſtars, ſo as often to afford many fields without a ſingle ſtar in it: that the nebulæ generally appeared ſome time after among ſtars of a certain conſiderable ſize, and but ſeldom among very ſmall ſtars: that when I came to one nebula, I generally found ſeveral more in the neighbourhood: that afterwards a conſiderable time paſſed before I came to another parcel. Theſe events being often repeated in different altitudes of my inſtrument, and ſome of them at conſiderable diſtances from each other, it occurred to me that the intermediate ſpaces between the ſweeps might alſo contain nebulæ; and finding this to hold good more than once, I ventured to give notice to my aſſiſtant at the clock, that 'I found myſelf on nebulous ground.' But how far theſe circumſtances of vacant places preceding and following the nebulous ſtrata, and their being as it were contained in a bed of ſtars ſparingly ſcattered between them, may hold good in more diſtant portions of the heavens, and which I have not been yet able to viſit in any regular manner, I ought by no means to hazard a conjecture. I may venture, however, to add a few particulars about the direction of ſome of the capital ſtrata or their branches. The well known nebula of Cancer, viſible to the naked eye, is probably one belonging to a certain ſtratum, in which I ſuppoſe it to be ſo placed as to lie neareſt to us. This ſtratum I ſhall call that of Cancer. It runs from ε Cancri towards the ſouth, over the 67th nebula of the *Connoiſſance des Temps*, which is a very beautiful and pretty much compreſſed cluſter of ſtars, eaſily to be ſeen by any good teleſcope; and in which I have obſerved above 200 ſtars at once in the field of view of my great reflector with a power of 157. This cluſter appearing ſo plainly with any good common teleſcope, and being ſo near to the one which may be ſeen with the naked eye, denotes it to be probably the next in diſtance to that within the quartile formed by γ, δ, η, θ. From the 67th nebula the ſtratum of Cancer proceeds towards the head of Hydra; but I have not yet had time to trace it farther than the equator.

228 Direction of ſome of the principal ſtrata of ſtars.

"Another ſtratum, which perhaps approaches nearer to the ſolar ſyſtem than any of the reſt, and whoſe ſituation is nearly at rectangles with the great ſidereal ſtratum in which the ſun is placed, is that of Coma Berenices, as I ſhall call it. I ſuppoſe the Coma itſelf to be one of the cluſters in it, and that on account of its nearneſs it appears to be ſo ſcattered. It has many capital nebulæ very near it: and in all probability this ſtratum runs out a very conſiderable way. It may perhaps even make the circuit of the heavens, though very likely not in one of the great circles of the ſphere; for unleſs it ſhould chance to interſect the great ſidereal ſtratum of the milky-way before mentioned, in the very place in which the ſun is ſtationed, ſuch an appearance would hardly be produced. However, if the ſtratum of Coma Berenices ſhould extend ſo far as I apprehend it may, the direction of it towards the north lies probably, with ſome windings, through the Great Bear onwards to Caſſiopeia, thence through the girdle of Andromeda and the Northern Fiſh, proceeding towards Cetus; while towards the ſouth it paſſes through the Virgin, probably on to the tail of Hydra and Centaurus."

229 Of the interior conſtruction of the heavens.

By a continued ſeries of obſervations, Dr Herſchel became confirmed in his notions; and in a ſucceeding paper * has given a ſketch of his opinions concerning the interior conſtruction of the heavens. "That the milky-way (ſays he) is a moſt extenſive ſtratum of ſtars of various ſizes, admits no longer of the leaſt doubt; and that our ſun is one of the heavenly bodies belonging to it is as evident. I have now viewed and gauged this ſhining zone in almoſt every direction, and find it compoſed of ſhining ſtars, whoſe number, by the account of thoſe gauges, conſtantly increaſes and decreaſes in proportion to its apparent brightneſs to the naked eye. But in order to develope the ideas of the univerſe that have been ſuggeſted by my late obſervations, it will be beſt to take the ſubject from a point of view at a conſiderable diſtance both of ſpace and time.

* *Philoſ. Tranſ.* vol. 75.

"Let us then ſuppoſe numberleſs ſtars of various ſizes ſcattered over an indefinite portion of ſpace, in ſuch

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such a manner as to be almost equally distributed through the whole. The laws of attraction, which no doubt extend to the remotest regions of the fixed stars, will operate in such a manner as most probably to produce the following remarkable effects.

230 Consequences of the laws of attraction acting among the stars.

"I. It will frequently happen, that a star, being considerably larger than its neighbouring ones, will attract them more than they will be attracted by others that are immediately around them; by which means they will be in time, as it were, condensed about a centre; or, in other words, form themselves into a cluster of stars of almost a globular figure, more or less regularly so according to the size and original distance of the surrounding stars. The perturbations of these mutual attractions must undoubtedly be very intricate, as we may easily comprehend, by considering what Sir Isaac Newton has said, *Princip.* lib. i. prop. 38. *et seq:* but in order to apply this great author's reasoning of bodies moving in ellipses to such as are here for a while supposed to have no other motion than what their mutual gravity has imparted to them, we must suppose the conjugate axes of these ellipses indefinitely diminished, whereby the ellipses will become straight lines.

231 Nebulæ, how formed.

"II. The next case, which will happen almost as frequently as the former, is where a few stars, though not superior in size to the rest, may change to be rather nearer each other than the surrounding ones; for here also will be formed a prevailing attraction in the combined centre of gravity of them all, which will occasion the neighbouring stars to draw together; not, indeed, so as to form a regular globular figure, but, however, in such a manner as to be condensed towards the common centre of gravity of the whole irregular cluster. And this construction admits of the utmost variety of shapes, according to the number and situation of the stars which first gave rise to the condensation of the rest.

"III. From the composition and repeated conjunction of both the foregoing forms, a third may be derived, when many large stars, or combined small ones, are situated in long extended regular or crooked rows, hooks, or branches; for they will also draw the surrounding ones so as to produce figures of condensed stars coarsely similar to the former, which gave rise to these condensations.

"IV. We may likewise admit of still more extensive combinations; when, at the same time that a cluster of stars is forming in one part of space, there may be another collecting in a different, but perhaps not far distant, quarter, which may occasion a mutual approach towards their common centre of gravity.

232 Vacancies, how they are occasioned in the heavens.

"V. In the last place, as a natural consequence of the former cases, there will be great cavities or vacancies formed by the retreat of the stars towards the various centres which attract them; so that, upon the whole, there is evidently a field of the greatest variety for the mutual and combined attractions of the heavenly bodies to exert themselves in.

"From this theoretical view of the heavens, which has been taken from a point not less distant in time than in space, we will now retreat to our own retired station, in one of the planets attending a star in its great combination with numberless others: and in order to investigate what will be the appearances from this contracted situation, let us begin with the naked eye. The stars of the first magnitude, being in all probability the nearest, will furnish us with a step to begin our scale. Setting off, therefore, with the distance of Sirius or Arcturus, for instance, as unity, we will at present suppose, that those of the second magnitude are at double, those of the third at treble, the distance, &c. Taking it for granted, then, that a star of the seventh magnitude (the smallest supposed visible with the naked eye) is about seven times as far as one of the first, it follows, that an observer who is enclosed in a globular cluster of stars, and not far from the centre, will never be able with the naked eye to see to the end of it; for since, according to the above estimations, he can only extend his view to above seven times the distance of Sirius, it cannot be expected that his eyes should reach the borders of a cluster which has perhaps not less than 50 stars in depth everywhere around him. The whole universe to him, therefore, will be comprised in a set of constellations richly ornamented with scattered stars of all sizes: Or, if the united brightness of a neighbouring cluster of stars should, in a remarkable clear night, reach his sight, it will put on the appearance of a small, faint, whitish, nebulous cloud, not to be perceived without the greatest attention. Let us suppose him placed in a much extended stratum or branching cluster of millions of stars, such as may fall under the third form of nebulæ already considered. Here also the heavens will not only be richly scattered over with brilliant constellations, but a shining zone or milky-way will be perceived to surround the whole sphere of the heavens, owing to the combined light of these stars which are too small, that is, too remote to be seen. Our observer's sight will be so confined, that he will imagine this single collection of stars, though he does not even perceive the thousandth part of them, to be the whole contents of the heavens. Allowing him now the use of a common telescope, he begins to suspect that all the milkiness of the bright path which surrounds the sphere may be owing to stars. He perceives a few clusters of them in various parts of the heavens, and finds also that there are a kind of nebulous patches: but still his views are not extended to reach so far as to the end of the stratum in which he is situated; so that he looks upon these patches as belonging to that system which to him seems to comprehend every celestial object. He now increases his power of vision; and, applying himself to a close observation, finds that the milky-way is indeed no other than a collection of very small stars. He perceives, that those objects which had been called *nebulæ*, are evidently nothing but clusters of stars. Their number increases upon him; and when he resolves one nebula into stars, he discovers ten new ones which he cannot resolve. He then forms the idea of immense strata of fixed stars, of clusters of stars, and of nebulæ; till, going on with such interesting observations, he now perceives, that all these appearances must naturally arise from the confined situation in which we are placed. *Confined* it may justly be called, though in no less a space than what appeared before to be the whole region of the fixed stars, but which now has assumed the shape of a crookedly branching nebula; not indeed one of the least, but perhaps very far from being the most considerable, of those numberless

233 How the stars must appear to us according to this hypothesis.

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numberless clusters that enter into the construction of the heavens."

Our author now proceeds to show that this theoretical view of the heavens is perfectly consistent with facts, and seems to be confirmed by a series of observations.

234 Arguments in favour of the foregoing theory from observations on nebulæ.

Many hundreds of nebulæ of the first and second forms are to be seen in the heavens; and their places, he says, will hereafter be pointed out; many of the third form described, and instances of the fourth related; a few of the cavities mentioned in the fifth particularized, though many more have been already observed: so that, "upon the whole (says he), I believe it will be found, that the foregoing theoretical view, with all its consequential appearances, as seen by an eye enclosed in one of the nebulæ, is no other than a drawing from nature, wherein the features of the original have been closely copied: and I hope the resemblance will not be called a bad one, when it shall be considered how very limited must be the pencil of an inhabitant of so small and retired a portion of an indefinite system in attempting the picture of so unbounded an extent."

235 Method of measuring the dimensions of the heavens.

Dr Herschel next presents us with a long table of star-gauges, or accounts of the number of stars at once in the field of his telescope, which go as high as 588; after which he proposes the following

PROBLEM.

"The stars being supposed nearly equally scattered, and their number, in a field of view of a known angular diameter, being given; to determine the length of the visual ray.

"Here, the arrangement of the stars not being fixed upon, we must endeavour to find which way they may be placed so as to fill a given space most equally. Suppose a rectangular cone cut into frustula by many equidistant planes perpendicular to the axis; then, if one star be placed at the vertex and another in the axis at the first intersection, six stars may be set around it so as to be equally distant from one another and from the central star. These positions being carried on in the same manner, we shall have every star within the cone surrounded by eight others at an equal distance from that star taken as a centre. Fig. 100. contains four sections of such a cone distinguished by alternate shades; which will be sufficient to explain what sort of arrangement I would point out.

"The series of the number of stars contained in the several sections will be 1, 7, 19, 37, 61, 91, &c. which continued to n terms, the sum of it, by the differential method, will be $na+n.\frac{n-1}{2}d'+n.\frac{n-1}{2}.\frac{n-2}{3}d''$, &c. where a is the first term, d', d'', d''', &c. the first, second, and third differences. Then, since $a=1$, $d'=6$, $d''=6$, $d'''=0$, the sum of the series will be n^3. Let S be the given number of stars; 1 the diameter of the base of the field of view; and B the diameter of the great rectangular cone; and by trigonometry we shall have $B=\frac{\text{Radius}}{\text{Tang.}\ \frac{1}{2}\ \text{field}}$. Now, since the field of view of a telescope is a cone, we shall have its solidity to that of the great cone of the stars formed by the above construction, as the square of the diameter of the base of the field of view, to the square of the diameter of the great cone, the height of both being the same; and the stars in each cone being in the ratio of the solidity, as being equally scattered, we have $n=\sqrt[3]{B^2S}$; and the length of the visual ray $=n-1$, which was to be determined." Another solution of this problem on the supposition of another arrangement of stars, is given; but Dr Herschel prefers the former.

236 Proofs of our sidereal system being a nebula.

From the data now laid down, Dr Herschel next endeavours to prove that the earth is 'the planet of a star belonging to a compound nebula of the third form.' "I shall now (says he) proceed to show, that the stupendous sidereal system we inhabit, this extensive stratum, and its secondary branch, consisting of many millions of stars, is in all probability *a detached nebula*. In order to go upon grounds that seem to me to be capable of great certainty, they being no less than an actual survey of the boundaries of our sidereal system, which I have plainly perceived as far as I have yet gone round it, everywhere terminated, and in most places very narrowly too, it will be proper to show the length of my sounding line, if I may so call it, that it may appear whether it was sufficiently long for the purpose.

237 Length of the line by which Dr Herschel measures the heavens.

"In the most crowded parts of the milky-way, I have had fields of view that contained no fewer than 588 stars, and these were continued for many minutes: so that in one quarter of an hour's time there passed no less than 116,000 stars through the field of view of my telescope. Now, if we compute the length of the visual ray, by putting $S=588$, and the diameter of the field of view 15 minutes, we shall find $n=\sqrt[3]{B^2S}=498$; so that it appears the length of what I have called my Sounding Line, or $n-1$, was not probably less than 497 times the distance of Sirius from the sun.

238 Cluster of stars defined.

"It may seem inaccurate that we should found an argument on the stars being equally scattered, when, in all probability, there may not be any two of them in the heavens whose mutual distance shall be equal to that of any other two given stars: but it should be considered, that when we take all the stars collectively, there will be a mean distance which may be assumed as the general one; and an argument founded on such a supposition will have in its favour the greatest probability of not being far short of truth. And here I must observe, that the difference between a crowded place and a cluster (none of the latter being put into the gauge table), may easily be perceived by the arrangement as well as the size and mutual distance of the stars; for in a cluster they are generally not only resembling each other pretty nearly in size, but a certain uniformity of distance also takes place: they are more and more accumulated towards the centre, and put on all the appearances which we should naturally expect from a number of them collected into a group at a certain distance from us. On the other hand, the rich parts of the milky-way, as well as those in the distant broad parts of the stratum, consist of a mixture of stars of all possible sizes, that are seemingly placed without any particular apparent order. Perhaps we might recollect, that a greater condensation towards the centre of our system than towards the borders of it should be taken into consideration; but with a nebula of the third form containing such various and extensive combinations

binations as I have found to take place in ours, this circumſtance, which in one of the firſt form would be of conſiderable moment, may, I think, be ſafely neglected.

"If ſome other high gauge be ſelected from the table, ſuch as 472 or 344, the length of the viſual ray will be found 461 and 415. And although, in conſequence of what has been ſaid, a certain degree of doubt may be left about the arrangement and ſcattering of the ſtars, yet when it is recollected, that in thoſe parts of the milky-way, where theſe high gauges were taken, the ſtars were neither ſo ſmall nor ſo crowded as they muſt have been, on a ſuppoſition of a much farther continuance of them, when certainly a milky or nebulous appearance muſt have come on, I need not fear to have over-rated the extent of my viſual ray; and indeed every thing that can be ſaid to ſhorten it will only contract the limits of our nebula, as it has in moſt places been of ſufficient length to go far beyond the bounds of it. Thus in the ſides of our ſtratum,

239 Extent of our nebula.

oppoſite to our ſituation in it, where the gauges often run below 5, our nebula cannot extend to 100 times the diſtance of Sirius; and the ſame teleſcope which could ſhow 588 ſtars in a field of view of 15 minutes, muſt certainly have preſented me alſo with the ſtars in theſe ſituations, had they been there. If we ſhould anſwer this by obſerving, that they might be at too great a diſtance to be perceived, it will be allowing that there muſt at leaſt be a vacancy amounting to the length of a viſual ray, not ſhort of 400 times the diſtance of Sirius; and this is amply ſufficient to make our nebula a detached one. It is true, that it would not be conſiſtent confidently to affirm that we were on an iſland, unleſs we had found ourſelves everywhere bounded by the ocean; and therefore I ſhall go no farther than the gauges will authorize; but conſidering the little depth of the ſtratum in all thoſe places which have been actually gauged, to which muſt be added all the intermediate parts that have been viewed and found to be much like the reſt, there is but little room to expect a connection between our nebula and any of the neighbouring ones. A teleſcope, with a much larger aperture than my preſent one, graſping together a greater quantity of light, and thereby enabling us to ſee farther into ſpace, will be the ſureſt means of completing and eſtabliſhing the arguments that have been uſed: for if our nebula is not abſolutely a detached one, I am firmly perſuaded that an inſtrument may be made large enough to diſcover the places where the ſtars continue onwards. A very bright milky nebuloſity muſt there undoubtedly come on, ſince the ſtars in a field of view will increaſe in the ratio of n^3 greater than that of the cube of the viſual ray. Thus, if 588 ſtars in a given field of view are to be ſeen by a ray of 497 times the diſtance of Sirius, when this is lengthened to 1000, which is but little more than double the former, the number of ſtars in the ſame field of view will be no leſs than 4774; for when the viſual ray r is given, the number of ſtars S will be $=\frac{n3}{B^2}$; where $n=r+$; and a teleſcope with a threefold power of extending into ſpace, or with a ray of 1500, which I think may eaſily be conſtructed, will give us 16,096 ſtars. Nor would theſe be ſo cloſe, but that a good power applied to ſuch an inſtrument might eaſily diſtinguiſh them; for they need not, if arranged in regular ſquares, approach nearer to each other than 6″.27; but the milky nebuloſity I have mentioned, would be produced by the numberleſs ſtars beyond them, which, in one reſpect, the viſual ray might alſo be ſaid to reach. To make this appear, we muſt return to the naked eye: which, as we have before eſtimated, can only ſee the ſtars of the ſeventh magnitude ſo as to diſtinguiſh them: but it is nevertheleſs very evident, that the united luſtre of millions of ſtars, ſuch as I ſuppoſe the nebula in Andromeda to be, will reach our ſight in the ſhape of a very ſmall faint nebuloſity; ſince the nebula of which I ſpeak may eaſily be ſeen in a fine evening. In the ſame manner, my preſent teleſcope, as I have argued, has not only a viſual ray that will reach the ſtars at 497 times the diſtance of Sirius, ſo as to diſtinguiſh them, and probably much farther, but alſo a power of ſhowing the united luſtre of the accumulated ſtars that compoſe a milky nebuloſity at a diſtance far exceeding the former limits: ſo that from theſe conſiderations it appears again highly probable, that my preſent teleſcope not ſhowing ſuch a nebuloſity in the milky-way, goes already far beyond its extent; and conſequently much more would an inſtrument, ſuch as I have mentioned, remove all doubt on the ſubject, both by ſhowing the ſtars in the continuation of the ſtratum, and by expoſing a very ſtrong milky nebuloſity beyond them, that could no longer be miſtaken for the dark ground of the heavens.

240 Analogical arguments in favour of his doctrine.

"To theſe arguments, which reſt on the firm baſis of a ſeries of obſervation, we may add the following conſiderations drawn from analogy. Among the great number of nebulæ which I have now already ſeen, amounting to more than 900, there are many which in all probability are equally extenſive with that which we inhabit; and yet they are all ſeparated from each other by very conſiderable intervals. Some, indeed, there are that ſeem to be double and treble; and though with moſt of theſe it may be that they are at a very great diſtance from each other, yet we allow that ſome ſuch conjunctions really are to be found; nor is this what we mean to exclude: But then theſe compound or double nebulæ, which are thoſe of the third and fourth forms, ſtill make a detached link in the great chain. It is alſo to be ſuppoſed, that there may be ſome thinly ſcattered ſolitary ſtars between the large interſtices of nebulæ; which being ſituated ſo as to be nearly equally attracted by the ſeveral cluſters when they were forming, remain unaſſociated: and though we cannot expect to ſee thoſe ſtars on account of their vaſt diſtance, yet we may well preſume that their number cannot be very conſiderable in compariſon to thoſe that are already drawn into ſyſtems; which conjecture is alſo abundantly confirmed in ſituations where the nebulæ are near enough to have their ſtars viſible; for they are all inſulated, and generally to be ſeen upon a very clear and pure ground, without any ſtar near them that might be thought to belong to them. And though I have often ſeen them in beds of ſtars, yet from the ſize of theſe latter we may be certain, that they were much nearer to us than thoſe nebulæ, and belong undoubtedly to our own ſyſtem."

Having thus determined that the viſible ſyſtem of nature, by us called the *univerſe*, conſiſting of all the celeſtial

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celestial bodies, and many more than can be seen by the naked eye, is only a group of stars or suns with their planets, constituting one of those patches called a *nebula*, and perhaps not one ten-thousandth part of what is really the universe, Dr Herschel goes on to delineate the figure of this vast nebula, which he is of opinion may now be done; and for this purpose he gives a table, calculating the distances of the stars which form its extreme boundaries, or the length of the visual ray in different parts, by the number of stars contained in the field of his telescope at different times, according to the principles already laid down. He does not, however, as yet attempt the whole nebula, but of a particular section, represented fig. 160. "I have taken one (says he) which passes through the poles of our system, and is at rectangles to the conjunction of the branches, which I have called its *length*. The name of *poles* seems to me not improperly applied to those points which are 90 degrees distant from a circle passing along the milky-way; and the north pole is here supposed to be situated in right ascension 186°, and polar distance (that is from the pole commonly so called) 58°. The section is one which makes an angle of 35° with our equator, crossing it in $124\frac{1}{2}$° and $304\frac{1}{2}$°. A celestial globe, adjusted to the latitude of 55° north, and having σ Ceti near the meridian, will have the plane of this section pointed out by the horizon. The visual rays are to be projected on the plane of the horizon of the latitude just mentioned, which may be done accurately enough by a globe adjusted in the manner directed. The stars in the border, which are marked larger than the rest, are those pointed out by the gauges. The intermediate parts are filled up by smaller stars, arranged in straight lines between the gauged ones. From this figure, which I hope is not a very inaccurate one, we may see that our nebula, as we observed before, is of the third form; that is, a very extensive, branching, compound congeries of many millions of stars, which most probably owes its origin to many remarkably large, as well as pretty closely scattered, small stars, that may have drawn together the rest. Now, to have some idea of the wonderful extent of this system, I must observe, that this section of it is drawn upon a scale where the distance of Sirius is no more than the 80th part of an inch; so that probably all the stars, which in the finest nights we are able to distinguish with the naked eye, may be comprehended within a sphere drawn round the large star near the middle, representing our situation in the nebula of less than half a quarter of an inch radius."

241 How the figure of our nebula may be delineated.

Dr Herschel now proceeds to offer some further thoughts on the origin of the nebulous strata of the heavens: in doing which he gives some hints concerning the antiquity of them. "If it were possible (says he) to distinguish between the parts of an indefinitely extended whole, the nebula we inhabit might be said to be one that has fewer marks of antiquity than any of the rest. To explain this idea perhaps more clearly, we should recollect, that the condensation of clusters of stars has been ascribed to a gradual approach; and whoever reflects on the number of ages that must have passed before some of the clusters that are to be found in my intended catalogue of them could be so far condensed as we find them at present, will not wonder if I ascribe a certain air of youth and vigour to many very regularly scattered regions of our sidereal stratum. There are, moreover, many places in it in which, if we may judge from appearances, there is the greatest reason to believe that the stars are drawing towards secondary centres, and will in time separate into clusters, so as to occasion many subdivisions. Hence we may surmise, that when a nebulous stratum consists chiefly of nebulæ of the first and second forms, it probably owes its origin to what may be called the decay of a great compound nebula of the third form; and that the subdivisions which happened to it in length of time, occasioned all the small nebulæ which sprung from it to lie in a certain range, according as they were detached from the primary one. In like manner, our system, after numbers of ages, may very possibly become divided, so as to give rise to a stratum of two or three hundred nebulæ; for it would not be difficult to point out so many beginning or gathering clusters in it. This throws a considerable light upon that remarkable collection of many hundreds of nebulæ which are to be seen in what I have called the *nebulous stratum* in Coma Berenices. It appears, from the extended and branching figure of our nebula, that there is room for the decomposed small nebulæ of a large reduced former great one to approach nearer to us in the sides than in any other parts. Nay, possibly there might originally be another very large joining branch, which in time became separated by the condensation of the stars: and this may be the reason of the little remaining breadth of our system in that very place; for the nebulæ of the stratum of the Coma are brightest and most crowded just opposite to our situation, or in the pole of our system. As soon as this idea was suggested, I tried also the opposite pole; where accordingly I have met with a great number of nebulæ, though under a much more scattered form.

242 Of the decay and recomposition of nebulæ.

"Some parts of our system indeed seem already to have sustained greater ravages of time than others; for instance in the body of the Scorpion is an opening or hole, which is probably owing to this cause. It is at least four degrees broad; but its height I have not yet ascertained. It is remarkable, that the 80 *Nebuleuse sans Etoiles* of the *Connoissance des Temps*, which is one of the richest and most compressed clusters of small stars I remember to have seen, is situated just on the west border of it, and would almost authorize a suspicion that the stars of which it is composed were collected from that place, and had left the vacancy. What adds not a little to this surmise is, that the same phenomenon is once more repeated with the fourth cluster of the *Connoissance des Temps*; which is also on the western border of another vacancy, and has moreover a small miniature cluster, or easily resolvable nebula, of about $2\frac{1}{2}$ minutes in diameter north, following it at no very great distance.

"There is a remarkable purity or clearness in the heavens when we look out of our stratum at the sides; that is, towards Leo, Virgo, and Coma Berenices on one hand, and towards Cetus on the other; whereas the ground of the heavens becomes troubled as we approach towards the length or height of it. These troubled appearances are easily to be explained by ascribing them to some of the distant straggling stars that yield hardly light enough to be distinguished.

And

And I have indeed often experienced this to be the cauſe, by examining theſe troubled ſpots for a long while together, when at laſt I generally perceived the ſtars which occaſioned them. But when we look towards the poles of our ſyſtem, where the viſual ray does not graze along the ſide, the ſtraggling ſtars will of courſe be very few in number; and therefore the ground of the heavens will aſſume that purity which I have always obſerved to take place in thoſe regions."

243 Univerſe compoſed of nebulæ. Thus, then, according to Dr Herſchel, the univerſe conſiſts of *nebulæ*, or innumerable collections of innumerable ſtars, each individual of which is a ſun not only equal, but much ſuperior to ours: at leaſt if the words of Mr Nicholſon have any weight; for he tells us, that "each individual ſun is deſtined to give light to *hundreds* of worlds that revolve about it, but which can no more be ſeen by us, on account of their great diſtance, than the ſolar planets can be ſeen from the fixed ſtars." "Yet (continues he), as in this unexplored, and perhaps unexplorable, abyſs of ſpace, it is no neceſſary condition that the planets ſhould be of the ſame magnitudes as thoſe belonging to our ſyſtem, it is not impoſſible but that planetary bodies may be diſcovered among the double and triple ſtars."

Nat. Phil. I. 195, 196.

Though in the above extracts from Dr Herſchel's papers, the words *condenſation*, *cluſters*, &c. of ſtars frequently occur, we are by no means from thence to imagine that any of the celeſtial bodies in our nebula are nearer to one another than we are to Sirius, whoſe diſtance is ſuppoſed not to be leſs than 400,000 times that of the ſun from us, or 38 millions of millions of miles. The whole extent of the nebula being in ſome places near 500 times as great, muſt be ſuch, that the light of a ſtar placed at its extreme boundary, ſuppoſing it to fly with the velocity of 12 millions of miles every minute, muſt have taken near 3000 years to reach us. Dr Herſchel, however, is by no means of opinion, that our nebula is the moſt conſiderable in the univerſe. "As we are uſed (ſays he) to call the appearance of the heavens, where it is ſurrounded with a bright zone, the *milky way*, it may not be amiſs to point out ſome other very remarkable nebulæ, which cannot well be leſs, but are probably much larger, than our own ſyſtem; and being alſo extended, the inhabitants of the planets that attend the ſtars which compoſe them, muſt likewiſe perceive the ſame phenomena: for which reaſon they may alſo be called *milky-ways*, by way of diſtinction.

244 Of the ſize and diſtance of nebulæ. "My opinion of their ſize is grounded on the following obſervations: There are many round nebulæ of the firſt form, of about five or ſix minutes in diameter, the ſtars of which I can ſee very diſtinctly; and on comparing them with the viſual ray calculated from ſome of my long gauges, I ſuppoſe by the appearance of the ſmall ſtars in thoſe guages, that the centres of theſe round nebulæ may be 600 times the diſtance of Sirius from us."—He then goes on to tell us, that the ſtars in ſuch nebulæ are probably twice as much condenſed as thoſe of our ſyſtem; otherwiſe the centre of it would not be leſs than 6000 times the diſtance of Sirius from us; and that it is poſſibly much underrated by ſuppoſing it only 600 times the diſtance of that ſtar.

"Some of theſe round nebulæ (ſays Dr Herſchel) have others near them, perfectly ſimilar in form, colour, and the diſtribution of ſtars, but of only half the diameter: and the ſtars in them ſeem to be doubly crowded, and only at about half the diſtance from each other. They are indeed ſo ſmall, as not to be viſible without the utmoſt attention. I ſuppoſe theſe miniature nebulæ to be at double the diſtance of the firſt. An inſtance equally remarkable and inſtructive is a caſe where, in the neighbourhood of two ſuch nebulæ as have been mentioned, I met with a third ſimilar, reſolvable, but much ſmaller and fainter nebula. The ſtars of it are no longer to be perceived; but a reſemblance of colour with the former two, and its diminiſhed ſize and light, may well permit us to place it at full twice the diſtance of the ſecond, or about four or five times the diſtance of the firſt. And yet the nebuloſity is not of the milky kind: nor is it ſo much as difficultly reſolvable or colourleſs. Now in a few of the extended nebulæ, the light changes gradually, ſo as from the reſolvable to approach to the milky kind; which appears to me an indication, that the milky light of nebulæ is owing to their much greater diſtance. A nebula, therefore, whoſe light is perfectly milky, cannot well be ſuppoſed to be at leſs than ſix or eight thouſand times the diſtance of Sirius; and though the numbers here aſſumed are not to be taken otherwiſe than as very coarſe eſtimates, yet an extended nebula, which an oblique ſituation, where it is poſſibly foreſhortened by one-half, two-thirds, or three-fourths of its length, ſubtends a degree or more in diameter, cannot be otherwiſe than of a wonderful magnitude, and may well outvie our milky way in grandeur."

Dr Herſchel next proceeds to give an account of ſeveral remarkable nebulæ, and then concludes thus: 245 Vaſt length of time requiſite to form the nebulæ. "Now, what great length of time muſt be required to produce theſe effects (the formation of nebulæ) may eaſily be conceived, when, in all probability, our whole ſyſtem of about 800 ſtars in diameter, if it were ſeen at ſuch a diſtance that one end of it might aſſume the reſolvable nebuloſity, would not, at the other end, preſent us with the irreſolvable, much leſs with the colourleſs and milky, ſort of nebuloſities.". Great indeed muſt be the length of time requiſite for ſuch diſtant bodies to form combinations by the laws of attraction, ſince, according to the diſtances he has aſſumed, the light of ſome of his nebulæ muſt be thirty-ſix or forty-eight thouſand years in arriving from them to us. It would be worth while then to inquire, whether *attraction* is a virtue propagated in time or not; or whether it moves quicker or ſlower than light? 246

Why the ſtars do not fall upon one another. In the courſe of Dr Herſchel's obſervations and inquiries concerning the ſtructure of the heavens, an objection occurred, that if the different ſyſtems were formed by the mutual attractions of the ſtars, the whole would be in danger of deſtruction by the falling of them one upon another. A ſufficient anſwer to this, he thinks, is, that if we can really prove the ſyſtem of the univerſe to be what he has ſaid, there is no doubt but that the great Author of it has amply provided for the preſervation of the whole, though it ſhould not appear to us in what manner this is effected. Several circumſtances, however, he is of opinion, manifeſtly tend to a general preſervation: as, in the firſt place, the indefinite extent of the ſidereal heavens; which muſt produce a balance that will effectually ſecure all the parts of the great whole from approaching to each other.

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other. "There remains then (says he) only to see how the particular ſtars belonging to ſeparate cluſters are prevented from ruſhing on to their centres of attraction." This he ſuppoſes may be done by projectile forces; "the admiſſion of which will prove ſuch a barrier againſt the ſeeming deſtructive power of attraction, as to ſecure from it all the ſtars belonging to a cluſter, if not for ever, at leaſt for millions of ages. Beſides, we ought perhaps to look upon ſuch cluſters, and the deſtruction of a ſtar now and then in ſome thouſands of ages, as the very means by which the whole is preſerved and renewed. Theſe cluſters may be the *laboratories* of the univerſe, wherein the moſt ſalutary remedies for the decay of the whole are prepared."

247 Of the planetary nebulæ.

In ſpeaking of the planetary nebulæ, by which name he diſtinguiſhes thoſe ſpots that are all over equally luminous, he ſays, "If we ſhould ſuppoſe them to be ſingle ſtars with large diameters, we ſhall find it difficult to account for their not being brighter, unleſs we ſhould admit that the intrinſic light of ſome ſtars may be very much inferior to that of the generality; which, however, can hardly be imagined to extend to ſuch a degree. We might ſuppoſe them to be comets about their aphelion, if the brightneſs, as well as magnitude of their diameters, did not oppoſe this idea; ſo that, after all, we can hardly find any hypotheſis ſo probable as that of their being nebulæ; but then they muſt conſiſt of ſtars that are compreſſed and accumulated in the higheſt degree. If it were not perhaps too hazardous to purſue a former ſurmiſe of a renewal in what I figuratively called the *Laboratories of the Univerſe*, the ſtars forming theſe extraordinary nebulæ, by ſome decay or waſte of nature being no longer fit for their former purpoſes, and having their projectile forces, if any ſuch they had, retarded in each other's atmoſphere, may ruſh at laſt together; and, either in ſucceſſion or by one general tremendous ſhock, unite into a new body. Perhaps the extraordinary and ſudden blaze of a new ſtar in Caſſiopeia's chair, in 1572, might poſſibly be of ſuch a nature. If a little attention to theſe bodies ſhould prove that, having no annual parallax, they belong moſt probably to the claſs of nebulæ, they may then be expected to keep their ſtation better than any one of the ſtars belonging to our ſyſtem, on account of their being probably at a very great diſtance."

248 Method of aſcertaining the ſituation of the ſtars.

As the fixed ſtars conſtantly keep nearly the ſame ſituation relative to each other, aſtronomers have agreed to refer to them, as to ſo many fixed points, the different motions of the other heavenly bodies. Hence the reaſon of dividing them into conſtellations. But it was neceſſary beſides, for the ſake of perfect preciſion to mark exactly the relative ſituation of every ſtar in the celeſtial ſphere. This is accompliſhed in the following manner.

"A great circle is ſuppoſed to paſs through the two poles, and through the centre of every ſtar. This circle is called a circle of *declination*. The arc of this circle included between the ſtar and the equator meaſures the *declination* of the ſtar. The declination of a ſtar then is its perpendicular diſtance from the equator. It is north or ſouth, according as the ſtar is ſituated on the north or ſouth ſide of the equator. All the ſtars ſituated in the ſame parallel of the equator have of courſe the ſame declination.

The declination then marks the ſituation of a ſtar north or ſouth from the equator. Preciſion requires ſtill another circle from which their diſtance eaſt or weſt may be marked, in order to give the real place. The *circle of declination* which paſſes through that point of the equator, called the *vernal equinoctial point*, has been choſen for that purpoſe. The diſtance of the circle of declination of a given ſtar from that point meaſured on the equator, or the arc of the equator included between the vernal equinox, and the circle of declination of the ſtar is called its *right aſcenſion*. If we know the declination and the right aſcenſion of a ſtar, we know its preciſe ſituation in the heavens.

The declination of any ſtar may be eaſily found by obſerving the following rule: Take the meridian altitude of the ſtar, at any place where the latitude is known; the complement of this is the *zenith diſtance*, and is called north or ſouth, as the ſtar is north or ſouth at the time of obſervation. Then, 1. When the latitude of the place and zenith diſtance of the ſtar are of different kinds, namely, one north and the other ſouth, their difference will be the declination; and it is of the ſame kind with the latitude, when that is the greateſt of the two, otherwiſe it is of the contrary kind. 2. If the latitude and the zenith diſtance are of the ſame kind, i. e. both north or both ſouth, their ſum is the declination; and it is of the ſame kind with the latitude.

To prove the truth of this rule, turn to fig. 86. where Z is the zenith of the place, EQ the equinoctial, and EZ the latitude. 1. Let r repreſent the place of a ſtar on the meridian, and Zr the zenith diſtance, the latitude being greater: then Er (the declination) will be equal to $EZ-Zr$ (the zenith diſtance); again, let c be the place of a ſtar in the meridian, when the zenith diſtance exceeds the latitude; then Ec (the declination $= Zc$ (the zenith diſtance) $-EZ$ (the latitude). And it is manifeſt, that in the former inſtance Z and r are on the ſame ſide of the equinoctial; and that in the latter caſe Z and c are on contrary ſides. 2dly, Let y be the place of a ſtar on the meridian, having its zenith diſtance Zy of the ſame kind with EZ the latitude of the place: then Ey (the declination) $= EZ + Zy$; and the declination is of the ſame kind as the latitude, becauſe Z and y are on the ſame ſide of the equinoctial. Q. E. D.

249 Rules for finding the declination,

For an Example, ſuppoſe that in north latitude 52° 15′, the meridian altitude of a ſtar is 51° 28′ on the ſouth; then 38° 32′ the zenith diſtance, being taken from 52° 15′ the latitude, leaves 13° 43′ for the declination of the ſtar *north*.

250 and right aſcenſion.

Having, by means like the above, found the declination of a ſtar, it becomes requiſite, in the next place, to know *the right aſcenſion*, as its ſituation with regard to the equator will then be known. Now the right aſcenſion being eſtimated from the point where the equator and ecliptic interſect each other in the ſpring, a point which is marked out by nothing that comes under the cognizance of our ſenſes; ſome phenomenon, therefore, muſt be choſen, whoſe right aſcenſion is either given, or may be readily known, at any time that the right aſcenſions of other objects may be diſcovered by compariſon with *it*. For this purpoſe nothing appears ſo

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ſo proper as the ſun; becauſe its motion is the moſt ſimple, and its right aſcenſion quickly found.

For if, in fig. 87. we have given QS the declination of the ſun (which may be eaſily taken every day at noon by obſervation), and the angle SEQ the obliquity of the ecliptic—i. e. one leg of a right-angled ſpherical triangle, and its oppoſite angle, to find the adjacent leg EQ, the right aſcenſion—it may be done by this proportion; as the tangent of the obliquity of the ecliptic: the tangent of the declination : : radius : the ſine of the right aſcenſion reckoned from the nearer equinoctial point.

For example: ſuppoſe on the 13th of February the ſun's ſouth declination is found to 13° 24′, and the obliquity of the ecliptic is 23° 28′; we ſhall thus find the ſun's right aſcenſion:

As tangt. 23° 28′	9.6376106
To tangt. 13° 24′	9.3770030
So is radius	10.0000000
To ſine 33° 16′ 58″	9.7393924

Here 33° 16′ 58″ is the ſun's diſtance from ♈; but as the declination is at that time decreaſing, and the ſun approaching ♈, this muſt be taken from 360°, and the remainder 326° 43′ 2″ is the right aſcenſion.

In a ſimilar manner may the ſun's right aſcenſion be calculated for every day at noon, and arranged in tables for uſe: for any intermediate time between one day at noon and the following, the right aſcenſion may be determined by proportion.

The longitude ES of the ſun, when required, may be readily found by the rules to aſcertain the hypothenuſe of the ſame triangle.

The apparent diurnal motion of the heavenly bodies being uniform, and performed in circles parallel to the equator, the interval of the times in which two ſtars paſs over any meridian muſt bear the ſame proportion to the period of the diurnal motion, as that arc of the equator intercepted between the two ſecondaries paſſing through the ſtars, does to 360°, as is evident from the nature of the ſphere: we may therefore find the right aſcenſion of a ſtar thus: Let an accurate pendulum clock be ſo regulated that the index may paſs over the twenty-four hours during the time in which any fixed ſtar after departing from the meridian will return to it again, which is rather leſs than twenty-four hours. Then let the index of a clock thus regulated be ſet to twelve o'clock when the ſun is on the meridian; and obſerve the time the index points to, when the fixed ſtar whoſe right aſcenſion is ſought comes to the meridian; which may be moſt accurately known by means of a tranſit teleſcope. Let theſe hours and parts, as marked by the clock, be converted into degrees, &c. of the equator, by allowing 15° to an hour; and the difference between the right aſcenſions of the fixed ſtar and the ſun will be known: this difference added to the ſun's right aſcenſion for that day at noon, gives the right aſcenſion of the fixed ſtar ſought.

Or, if a clock whoſe dial plate is divided into 360°, inſtead of twelve hours, be ordered in ſuch a manner, that the index may paſs round the whole circle in the interval which a ſtar requires to come to the ſame meridian again, and another index be ſo managed as to point out the ſexageſimal parts: then, when the ſun is on the meridian, let the indices of the clock be put to

his right aſcenſion at noon that day; and when the ſtar comes to the meridian, its right aſcenſion will be ſhown by the clock, without any kind of reduction.

The ſtars are referred likewiſe to the ecliptic as well as to the equator. In that caſe the terms *longitude* and *latitude* are uſed.

251 Longitude of the heavenly bodies.

The longitude of any of the heavenly bodies is an arc of the ecliptic contained between the firſt point of Aries, and a ſecondary to the ecliptic or circle of latitude, paſſing through the body; it is always meaſured according to the order of the ſigns. If the body be ſuppoſed ſeen from the centre of the earth, it is called *geocentric* longitude; but if it be ſuppoſed ſeen from the centre of the ſun, then is the longitude *heliocentric*.

252 Latitudes.

The latitude of a heavenly body is its diſtance from the ecliptic, meaſured upon a ſecondary to the ecliptic drawn through the body. If the latitude be ſuch as is ſeen from the earth's centre, it is called *geocentric* latitude; but if it be ſuppoſed ſeen from the centre of the ſun, it is *heliocentric*.

The equator being the principal circle which reſpects the earth, the latitudes and longitudes of terreſtrial objects are referred to it; and, for a ſimilar reaſon (the ſun's motion in the ecliptic rendering that the principal of the celeſtial circles), the ſituations of heavenly objects are generally aſcertained by their latitudes and longitudes referred to the ecliptic: it has therefore become a uſeful problem to find the latitudes and longitudes of the ſtars, &c. having their declinations, and right aſcenſions, with the obliquity of the ecliptic, given. One of the beſt methods of performing this problem has been thus inveſtigated: Let S be the place of the body (fig. 88.), EC the ecliptic, EQ the equator; and SL and SR being reſpectively perpendicular to EC and EQ, ER will repreſent the right aſcenſion, SR the declination, EL the longitude, and SL the latitude; then, by ſpherics, rad. : ſine ER : : co-tang. SR : co-tang. SER; and SER∓CEQ=SEL. Alſo, co-ſine SER : rad. : : tang. ER : tang. ES; and rad. : co-ſine SEL : : tang. ES : tang. EL; therefore, co-ſine SER : co-ſine SEL : : tang. ER : tang. EL; whence we readily get, $\frac{\text{co-ſine SEL} \times \text{tang. ER}}{\text{co-ſine SER}}$ = the tangent of EL, the longitude. Then, rad. : ſine of EL : : tang. SEL : tang. SL, the latitude.

253 How found.

But the ſame thing may be performed very expeditiouſly by means of the following excellent rule, given by Dr Maſkelyne, the preſent worthy aſtronomer royal:

1. The ſine of the right aſcenſion + co-tang. declination −10= co-tang. of arc A, which call *north*, or *ſouth*, according as the declination is north or ſouth. 2. Call the obliquity of the ecliptic ſouth in the ſix firſt ſigns of right aſcenſion, and north in the ſix laſt. Let the ſum of arc A, and obliquity of ecliptic, according to their titles, = arc B with its proper title. [If one be north and the other ſouth, the proper title is that which belongs to the greater; and in this caſe, arc B is their difference.] 3. The arithmetical complement of co-ſine arc A + co-ſine arc B × tang. right aſcenſion = tangent of the longitude: this is of the ſame kind as the right aſcenſion, unleſs arc B be more than 90°, when the quantity found of the ſame kind as

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the right aſcenſion muſt be ſubtracted from 12 ſigns, or 360°. 4. The ſine of longitude + tang. arc B —10= tang. of the required latitude, of the ſame title as arc B. Note, If the longitude be found near 0° or near 180°, for the ſine of longitude, in the laſt operation, ſubſtitute tang. longitude + co-ſine longitude —10; and then the laſt operation will be tang. longitude + co-ſine longitude + tang. arc B —20= tang. latitude. By ſine, tang. &c. are meant logarithm ſine, log. tang. &c.

This rule may be exemplified by inquiring what are the latitude and longitude of a ſtar whoſe declination is 12° 59′ north, and right aſcenſion 4ˢ 29° 38′, the obliquity of the ecliptic being 23° 28′?

Here, ſine of right aſcenſion	4ˢ 29° 38′	9·7037486
Co-tang. of declination	12 59	10·6372126
Co-tang. of arc A, north	24 31	10·34069612
Obliquity of ecliptic, ſouth	23 28	
Arc B, north -	1 3 coſ.	9·9999271
Arith. comp. of co-ſine arc A		0·0410347
Tangent of right aſcenſion		9·7678344
Tangent of longitude	147° 13′ 26″	9·8087962
Or 4ˢ 27° 13′ 26″, anſwering to 27° 13′ 26″ of Leo.		
Then, ſine of longitude	- -	9·7334843
Tangent of arc B	- -	8·2631153
Tang. of latitude, north,	34′ 6″	7·9965996

254 Stars vary in right aſcenſion and declination.

Aſtronomers have obſerved that the ſtars vary in right aſcenſion and in declination, but keep the ſame latitude: hence it was concluded that their variations in declination and right aſcenſion were owing to the revolution of the celeſtial ſphere round the poles of the ecliptic. Or they may be accounted for by ſuppoſing that the poles of the equator revolve ſlowly round thoſe of the ecliptic. This revolution is called the preceſſion of the equinoxes. A more particular account of it will be neceſſary.

255 Obſervations of the Aſiatic ſhepherds.

By a long ſeries of obſervations, the ſhepherds of Aſia were able to mark out the ſun's path in the heavens; he being always in the oppoſite point to that which comes to the meridian at midnight, with equal but oppoſite declination. Thus they could tell the ſtars among which the ſun then was, although they could not ſee them. They diſcovered that this path was a great circle of the heavens, afterwards called the Ecliptic; which cuts the equator in two oppoſite points, dividing it, and being divided by it, into two equal parts. They farther obſerved, that when the ſun was in either of theſe points of interſection, his circle of diurnal revolution coincided with the equator, and therefore the days and nights were equal. Hence the equator came to be called the Equinoctial line, and the points in which it cuts the ecliptic were called the Equinoctial points, and the ſun was then ſaid to be in the equinoxes. One of theſe was called the Vernal and the other the Autumnal Equinox.

256 To determine the time of the ſun's occupying the equinoctial points.

It was evidently an important problem in practical aſtronomy to determine the exact moment of the ſun's occupying theſe ſtations; for it was natural to compute the courſe of the year from that moment. Accordingly this has been the leading problem in the aſtronomy of all nations. It is ſuſceptible of conſiderable preciſion, without any apparatus of inſtruments. It is only neceſſary to obſerve the ſun's declination on the noon of two or three days before and after the equinoctial day. On two conſecutive days of this number, his declination muſt have changed from north to ſouth, or from ſouth to north. If his declination on one day was obſerved to be 21′ north, and on the next 5′ ſouth, it follows that his declination was nothing, or that he was in the equinoctial point about 23 minutes after 7 in the morning of the ſecond day. Knowing the preciſe moments, and knowing the rate of the ſun's motion in the ecliptic, it is eaſy to aſcertain the preciſe point of the ecliptic in which the equator interſected it.

257 Hipparchus's diſcoveries.

By a ſeries of ſuch obſervations made at Alexandria between the years 161 and 127 before Chriſt, Hipparchus, the father of our aſtronomy, found that the point of the autumnal equinox was about ſix degrees to the eaſtward of the ſtar called Spica virginis. Eager to determine every thing by multiplied obſervations, he ranſacked all the Chaldean, Egyptian, and other records, to which his travels could procure him acceſs, for obſervations of the ſame kind; but he does not mention his having found any. He found, however, ſome obſervations of Ariſtillus and Timochares made about 150 years before. From theſe it appeared evident that the point of the autumnal equinox was then about eight degrees eaſt of the ſame ſtar. He diſcuſſes theſe obſervations with great ſagacity and rigour; and, on their authority, he aſſerts that the equinoctial points are not fixed in the heavens, but move to the weſtward about a degree in 75 years or ſomewhat leſs.

258 Why called the preceſſion of the equinoxes.

This motion is called the Preceſſion of the Equinoxes, becauſe by it the time and place of the ſun's equinoctial ſtation precedes the uſual calculations: it is fully confirmed by all ſubſequent obſervations. In 1750 the autumnal equinox was obſerved to be 20° 21′ weſtward of Spica Virginis. Suppoſing the motion to have been uniform during this period of ages, it follows that the annual preceſſion is about 50″$\frac{1}{3}$; that is, if the celeſtial equator cuts the ecliptic in a particular point on any day of this year, it will on the ſame day of the following year cut it in a point 50″$\frac{1}{3}$ to the weſt of it, and the ſun will come to the equinox 20′ 23″ before he has completed his round of the heavens. Thus the equinoctial or tropical year, or true year of ſeaſons, is ſo much ſhorter than the revolution of the ſun or the ſidereal year.

259 Importance of the diſcovery.

It is this diſcovery that has chiefly immortalized the name of Hipparchus, though it muſt be acknowledged that all his aſtronomical reſearches have been conducted with the ſame ſagacity and intelligence. It was natural therefore for him to value himſelf highly for the diſcovery. It muſt be acknowledged to be one of the moſt ſingular that has been made, that the revolution of the whole heavens ſhould not be ſtable, but its axis continually changing. For it muſt be obſerved, that ſince the equator changes its poſition, and the equator is only an imaginary circle, equidiſtant from the two poles or extremities of the axis; theſe poles and this axis muſt equally change their poſitions. The equinoctial points make a complete revolution in about 25,745 years, the equator being all the while inclined to the ecliptic in nearly the ſame angle. Therefore the poles of this diurnal revolution muſt deſcribe a circle

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circle round the poles of the ecliptic at the diſtance of about 23½ degrees in 25,745 years; and in the time of Timochares the north pole of the heavens muſt have been 30 degrees eaſtward of where it now is.

260 Hipparchus has been accuſed of plagiariſm,

Hipparchus has been accuſed of plagiariſm and inſincerity in this matter. It is now very certain that the preceſſion of the equinoxes was known to the aſtronomers of India many ages before the time of Hipparchus. It appears alſo that the Chaldeans had a pretty accurate knowledge of the year of ſeaſons. From their ſaros we deduce their meaſure of this year to be 365 days 5 hours 49 minutes and 11 ſeconds, exceeding the truth only by 26″, and much more exact than the year of Hipparchus. They had alſo a ſidereal year of 365 days 6 hours 11 minutes. Now what could occaſion an attention to two years, if they did not ſuppoſe the equinoxes moveable? The Egyptians alſo had a knowledge of ſomething equivalent to this: for they had diſcovered that the dog-ſtar was no longer the faithful forewarner of the overflowing of the Nile; and they combined him with the ſtar Fomalhaſet * in their myſtical calendar. This knowledge is alſo involved in the precepts of the Chineſe aſtronomy, of much older date than the time of Hipparchus.

* See *Dupins ſur le zodiaque des Egyptiens. Mem. de l'Acad. des Inſcrip.*

261 But falſely.

But all theſe acknowledged facts are not ſufficient for depriving Hipparchus of the honour of the diſcovery, or fixing on him the charge of plagiariſm. This motion was a thing unknown to the aſtronomers of the Alexandrian ſchool, and it was pointed out to them by Hipparchus in the way in which he aſcertained every other poſition in aſtronomy, namely, as the mathematical reſult of actual obſervations, and not as a thing deducible from any opinions on other ſubjects related to it. We ſee him, on all other occaſions, eager to confirm his own obſervations, and his deductions from them, by every thing he could pick up from other aſtronomers; and he even adduced the above-mentioned practice of the Egyptians in corroboration of his doctrine. It is more than probable then that he did not know any thing more. Had he known the Indian preceſſion of 54″ annually, he had no temptation whatever to withhold him from uſing it in preference to one which he acknowledges to be inaccurate, becauſe deduced from the very ſhort period of 150 years, and from the obſervations of Timochares, in which he had no great confidence.

Small periodical irregularities in the inclination of the equator to the ecliptic, and in the preceſſion of the equinoxes, were diſcovered and examined by Bradley with great ſagacity. He found that the pole deſcribed an epicycle, whoſe diameter was about 18″, having for its centre that point of the circle round the pole of the ecliptic in which the pole would have been found independent of this new motion. He alſo obſerved, that the period of this epicyclical motion was 18 years and ſeven months. It ſtruck him, that this was preciſely the period of the revolution of the nodes of the moon's orbit. He gave a brief account of theſe reſults to Lord Macclesfield, then preſident of the Royal Society, in 1747. Mr Machin, to whom he alſo communicated the obſervations, gave him in return a very neat mathematical hypotheſis, by which the motion might be calculated.

Let E (fig. 89.) be the pole of the ecliptic, and SPQ a circle diſtant from it 23° 28′, repreſenting the circle deſcribed by the pole of the equator during one revolution of the equinoctial points. Let P be the place of this laſt-mentioned pole at ſome given time. Round P deſcribe a circle ABCD, whoſe diameter AC is 18″. The real ſituation of the pole will be in the circumference of this circle; and its place, in this circumference, depends on the place of the moon's aſcending node. Draw EPF and GPL perpendicular to it; let GL be the colure of the equinoxes, and EF the colure of the ſolſtices. Dr Bradley's obſervations ſhowed that the pole was in A when the node was in L, the vernal equinox. If the node recede to H, the winter ſolſtice, the pole is in B. When the node is in the autumnal equinox at G, the pole is at C; and when the node is in F, the ſummer ſolſtice, the pole is in D. In intermediate ſituations of the moon's aſcending node, the pole is in a point of the circumference ABCD, three ſigns or 90° more advanced.

262 Mathematical theory if the poles of the equator be ſuppoſed to deſcribe a circle.

263 More exact if an ellipſe be ſubſtituted for the circle.

Dr Bradley, by comparing together a great number of obſervations, found that the mathematical theory, and the calculation depending on it, would correſpond much better with the obſervations, if an ellipſe were ſubſtituted for the circle ABCD, making the longer axis AC 18″ and the ſhorter, BD, 16″. M. d'Alembert determined, by the phyſical theory of gravitation, the axis to be 18″ and 13″.4.

264 Theſe obſervations and this theory are facts in aſtronomy.

Theſe obſervations, and this mathematical theory, muſt be conſidered as ſo many facts in aſtronomy, and we muſt deduce from them the methods of computing the places of all celeſtial phenomena, agreeable to the univerſal practice of determining every point of the heavens by its longitude, latitude, right aſcenſion, and declination.

265 Obliquity of the ecliptic.

It is evident, in the firſt place, that the equation of the pole's motion makes a change in the obliquity of the ecliptic. The inclination of the equator to the ecliptic is meaſured by the arch of a great circle intercepted between their poles. Now, if the pole be in O inſtead of P, it is plain that the obliquity is meaſured by EO inſtead of EP. If EP be conſidered as the mean obliquity of the ecliptic, it is augmented by 9″ when the moon's aſcending node is in the vernal equinox, and conſequently the pole in A. It is on the contrary, diminiſhed 9″ when the node is in the autumnal equinox, and the pole in C; and it is equal to the mean when the node is in the colure of the ſolſtices. This change of the inclination of the earth's axis to the plane of the ecliptic was called the nutation of the axis by Sir Iſaac Newton.

Dr Bradley alſo diſcovered a general and periodical motion in all the ſtars, which alter a little their relative ſituations. To form an idea of this motion, let us ſuppoſe that each ſtar deſcribes annually a ſmall circumference parallel to the ecliptic, whoſe centre is the mean poſition of the ſtar, and whoſe diameter, as ſeen from the earth, ſubtends an angle of about 40″; and that it was in that circumference as the ſun in its orbit, but ſo that the ſun always precedes it by 90°. This circumference, projected upon the ſurface of the celeſtial ſphere, appears under the form of an ellipſe, more or leſs flattened according to the height of the ſtar above the equator, the ſmaller axis of the ellipſe being to the greater axis as the ſine of that height to radius. Theſe periodical movements of the ſtars have received the name of *aberrations of the fixed ſtars*.

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Besides these general motions, particular motions have been detected in several stars, excessively slow indeed, but which a long succession of ages has rendered sensible. These motions have been chiefly observed in Sirius and Arcturus. But astronomers suppose that all the stars have similar motions, which may become evident in process of time.

266 Distance of the fixed stars immeasurable.

No method of ascertaining the distance of fixed stars hath hitherto been found out. Those who have formed conjectures concerning them, have thought that they were at least 400,000 times farther from us than we are from the sun.

They are said to be fixed, because they have been generally observed to keep at the same distances from each other; their apparent diurnal revolutions being caused solely by the earth's turning on its axis.

267 Why they seem so big to our naked eye.

They appear of a sensible magnitude to the bare eye, because the retina is affected not only by the rays of light which are emitted directly from them, but by many thousands more, which falling upon our eyelids, and upon the aerial particles about us, are reflected into our eyes so strongly as to excite vibrations not only in those points of the retina where the real images of the stars are formed, but also in other points at some distance round about. This makes us imagine the stars to be much bigger than they would appear if we saw them only by the few rays which come directly from them, so as to enter our eyes without being intermixed with others. Any one may be sensible of this, by looking at a star of the first magnitude through a long narrow tube; which, though it takes in as much of the sky as would hold 1000 such stars, yet scarce renders that one visible.

The more a telescope magnifies, the less is the aperture through which the star is seen; and consequently, the fewer rays it admits into the eye. Now, since the stars appear less in a telescope which magnifies 200 times, than they do to the bare eye, insomuch that they seem to be only indivisible points, it proves at once that the stars are at immense distances from us, and that they shine by their own proper light. If they shone by borrowed light, they would be as invisible without telescopes as the satellites of Jupiter are; for these satellites appear bigger when viewed with a good telescope than the largest fixed stars do.

268 Parallax of the fixed stars.

Dr Herschel has proposed a method of ascertaining the parallax of the fixed stars, something similar, but more complete, than that mentioned by Galileo and others; for it is by the parallax of the fixed stars that we should be best able to determine their distance. The method pointed out by Galileo, and first attempted by Hooke, Flamstead, Molineux, and Bradley, of taking distances of stars from the zenith that pass very near it, has given us a much juster idea of the immense distance of the stars, and furnished us with an approximation to the knowledge of their parallax, that is much nearer the truth than we ever had before. But Dr Herschel mentions the insufficiency of their instruments, which were similar to the present zenith sectors, the method of zenith distances being liable to considerable errors on account of refraction, the change of position of the earth's axis arising from nutation, precession of the equinoxes, and other causes, and the aberration of the light. The method of his own is by means of double stars; which is exempted from these errors, and of such a nature that the annual parallax, even if it should not exceed the tenth part of a second, may still become more visible, and be ascertained, at least to a much greater degree of approximation than it has ever been done. This method is capable of every improvement which the telescope and mechanism of micrometers can furnish. The method and its theory will be seen by the following investigation, extracted from his paper on the subject. (*Phil. Trans.* vol. lxxii. p. 82.) Let O, E, (fig. 90.) be two opposite points in the annual orbit, taken in the same plane with two stars *a*, *b*, of unequal magnitudes. Let the angle *a* O *b* be observed, when the earth is at O, and *a* E *b* be observed when the earth is at E. From the difference of these angles, if there should be any, we may calculate the parallax of the stars, according to the theory subjoined. These two stars ought to be as near each other as possible, and also to differ as much in magnitude as we can find them.

Dr Herschel's theory of the annual parallax of double stars, with the method of computing from thence what is generally called the parallax of the fixed stars, or of single stars of the first magnitude, such as are nearest to us, supposes, *first*, that the stars, one with another, are about the size of the sun; and, *secondly*, that the difference of their apparent magnitudes is owing to their different distances; so that the star of the second, third, or fourth magnitude, is two, three, or four times as far off as one of the first. These principles which he premises as postulata, have so great a probability in their favour, that they will hardly be objected to by those who are in the least acquainted with the doctrine of chances. Accordingly, let OE (fig. 91.) be the whole diameter of the earth's annual orbit, and let *a*, *b*, *c*, be three stars situated in the ecliptic, in such a manner that they may be seen all in one line O *a b c*, when the earth is at O. Let the line O *a b c* be perpendicular to OE, and draw PE parallel to *c* O; then, if O *a*, *a b*, *b c*, are equal to each other, *a* will be a star of the first magnitude, *b* of the second, and *c* of the third. Let us now suppose the angle O *a* E, or parallax of the whole orbit of the earth, to be 1″ of a degree; then we have PE *a* = O *a* E = 1″: and because very small angles, having the same subtense OE, may be taken to be in the inverse ratio of the lines O *a*, O *b*, O *c*, &c. we shall have O *b* E = $\frac{1}{2}$″, O *c* E = $\frac{1}{3}$″, &c. Now when the earth is removed to E, we shall have PE *b* = E *b* *o* = $\frac{1}{2}$″, and PE *a* — PE *b* = *a* E *b* = $\frac{1}{2}$″, i. e. the stars *a*, *b*, will appear to be $\frac{1}{2}$″ distant. We also have PE *c* = E *c* O = $\frac{1}{3}$″, and PE *a* — PE *c* = *a* E *c* = $\frac{2}{3}$″; i. e. the stars *a*, *c*, will appear to be $\frac{2}{3}$″ distant when the earth is at E. Now, since we have *b* EP = $\frac{1}{2}$″, and *c* EP = $\frac{1}{3}$″, therefore *b* EP — *c* EP = *b* E *c* = $\frac{1}{2}$″ — $\frac{1}{3}$″ = $\frac{1}{6}$″; i. e. the stars *b*, *c*, will appear to be only $\frac{1}{6}$″ removed from each other when the earth is at E. Whence we may deduce the following expression, to denote the parallax that will become visible in the change of distance between the two stars, by the removal of the earth from one extreme of its orbit to the other. Let P express the total parallax of a fixed star of the first magnitude, M the magnitude of the largest of the two stars, *m* the magnitude of the smallest, and *p* the partial parallax to to be observed by the change in the distance of a double star; then will $p=\frac{m-M}{Mm}P$; and p, being found by observation, will give us $P=\frac{PMm}{m-M}$. *E. G.* Suppose a star of the first magnitude should have a small star of the twelfth magnitude near it; then will the partial parallax we are to expect to see be $\frac{12\times 1P}{12-1}$, or $\frac{11}{12}$ of the total parallax of a fixed star of the first magnitude; and if we should, by observation, find the partial parallax between two such stars to amount to $1''$, we shall have the total parallax $P=\frac{1\times 1\times 12}{12-1}=1''.0909$. If the stars are of the third and twenty-fourth magnitude, the partial parallax will be $\frac{24-3}{3\times 24}=\frac{21}{72}P$; and if, by observation, p is found to be a tenth of a second, the whole parallax will come out $\frac{.1\times 3\times 24}{24-3}=0''.3428$.

Farther, suppose the stars, being still in the ecliptic, to appear in one line, when the earth is in any other part of its orbit between O and E; then will the parallax still be expressed by the same algebraic formula, and one of the maxima will still lie at O, the other at E; but the whole effect will be divided into two parts, which will be in proportion to each other as radius − sine to radius + sine of the stars distance from the nearest conjunction or opposition.

When the stars are anywhere out of the ecliptic, situated so as to appear in one line O *a b c* perpendicular to OE, the maximum of parallax will still be expressed by $\frac{m-M}{Mm}P$; but there will arise another additional parallax in the conjunction and opposition, which will be to that which is found 90° before or after the sun, as the sine (*S*) of the latitude of the stars seen at O is to the radius (R); and the effect of this parallax will be divided into two parts; half of it lying on one side of the large star, the other half on the other side of it. This latter parallax, moreover, will be compounded with the former, so that the distance of the stars in the conjunction and opposition will then be represented by the diagonal of a parallelogram, whereof the two semiparallaxes are the sides; a general expression for which will be $\sqrt{\left|\frac{m-M}{2MP}P\right|^2\times\frac{SS}{RR}+1}$; for the stars will apparently describe two ellipses in the heavens, whose transverse axes will be to each other in the ratio of M to m (fig. 93.), and A *a*, B *b*, C *c*, D *d*, will be the cotemporary situations. Now, if *b* Q be drawn parallel to AC, and the parallelogram *b q* BQ be completed we shall have $bQ=\frac{1}{2}CA-\frac{1}{2}ca=\frac{1}{2}Cc=\frac{1}{2}p$, or semiparallax 90° before or after the sun, and B *b* may be resolved into, or is compounded of, *b* Q and *b q*; but $bq=\frac{1}{2}BD-\frac{1}{2}bd=$ the semiparallax in the conjunction or opposition. We also have R : S :: *b* Q : $bq=\frac{pS}{2R}$; therefore the distance B *b* (or D *d*) $=\sqrt{\left|\frac{p}{2}\right|^2\times\left|\frac{pS}{2R}\right|^2}$; and by substituting the value of p into this expression, we obtain $\sqrt{\left|\frac{m-M}{2Mm}P\right|^2\times\frac{SS}{RR}+1}$, as above. When the stars are in the pole of the ecliptic, *b q* will become equal to *b* Q, and B *b* will be 7071 $P\frac{m-M}{Mm}$. Again, let the stars be at some distance, *e. g.* 5″ from each other, and let them both be in the ecliptic. This case is resolvable into the first; for imagine the star *a* (fig. 92.) to stand at *x*, and in that situation the stars *x*, *b*, *c*, will be in one line, and their parallax expressed by $\frac{m-M}{Mm}P$. But the angle *a* E *x* may be taken to be equal to *a* O *x*; and as the foregoing formula gives us the angles *x* E *b* *x* E *c*, we are to add *a* E *x* or 5″ to *x* E *b*, and we shall have *a* E *b*. In general, let the distance of the stars be *d*, and let the observed distance at E be D, then will $D=d+p$, and therefore the whole parallax of the annual orbit will be expressed by $\frac{DMm-dMm}{m-M}=P$.

Suppose the two stars now to differ only in latitude, one being in the ecliptic, the other, *e. g.* 5 north when seen at O. This case may also be resolved by the former; for imagine the stars *b*, *c*, (fig. 91.) to be elevated at right angles above the plane of the figure, so that *a* O *b*, or *a* O *c*, may make an angle of 5″ at O; then, instead of the line O *a b c*, E *a*, E b, E *c*, EP, imagine them all to be planes at right angles to the figure; and it will appear that the parallax of the stars in longitude must be the same as if the small star had been without latitude. And since the stars *b*, *c*, by the motion of the earth from O to E, will not change their latitude, we shall have the following construction for finding the distance of the stars *a b*, *a c*, at E, and from thence the parallax B. Let the triangle *a b β* (fig. 94.) represent the situation of the stars; *a b* is the subtense of 5″, the angle under which they are supposed to be seen at O. The quantity *b β* by the former theorem is found, $\frac{m-M}{Mm}P$, which is the partial parallax that would have been seen by the earth's moving from O to E, if both stars had been in the ecliptic; but on account of the difference in latitude, it will be now represented by *a β*, the hypothenuse of the triangle *a b β*: therefore, in general, putting $ab=d$, and $a\beta=D$, we have $\sqrt{\frac{DD-dd\times Mm}{m-M}}=P$. Hence D being taken by observation, and *d*, M, and *m*, given, we obtain the total parallax.

If the situation of the stars differs in longitude as well as latitude, we may resolve this case by the following method. Let the triangle *a b β* (fig. 169.) represent the situation of the stars, $ab=d$ being their distance seen at O, $a\beta=D$ their distance seen at E. That the change *b β*, which is produced by the earth's motion will be truly expressed by $\frac{m-M}{Mm}P$ may be proved as before, by supposing the star *a* to have been placed at

α. Now let the angle of poſition $b\,a\,\alpha$ be taken by a micrometer, or by any other method ſufficiently exact; then, by ſolving the triangle $a\,b\,\alpha$, we ſhall have the longitudinal and latitudinal differences $a\,\alpha$ and $b\,\alpha$ of the two ſtars. Put $a\,\alpha = x$, $b\,\alpha = y$, and it will be $\overline{x + b\,\beta = a\,q}$, whence $D = \sqrt{\overline{x + \frac{m - MP}{Mm}}\Big|^{2} + y\,y}$; and $\frac{\sqrt{D^2 - y^2} \times M^2 m - Mm}{m - M} = P$.

If neither of the ſtars ſhould be in the ecliptic, nor have the ſame longitude or latitude, the laſt theorem will ſtill ſerve to calculate the total parallax whoſe maximum will lie in E. There will, moreover, ariſe another parallax, whoſe maximum will be in the conjunction and oppoſition, which will be divided, and lie on different ſides of the large ſtar; but as we know the whole parallax to be exceedingly ſmall, it will not be neceſſary to inveſtigate every particular caſe of this kind; for by reaſon of the diviſion of the parallax, which renders obſervations taken at any other time, except where it is greateſt, very unfavourable, the formulæ would be of little uſe. Dr Herſchel cloſes his account of this theory with a general obſervation on the time and place where the maxima of parallax will happen.

When two unequal ſtars are both in the ecliptic, or, not being in the ecliptic, have equal latitudes, north or ſouth, and the largeſt ſtar has moſt longitude; the maximum of the apparent diſtance will be when the ſun's longitude is 90 degrees more than the ſtars, or when obſerved in the morning; and the minimum when the longitude of the ſun is 90 degrees leſs than that of the ſtars, or when obſerved in the evening. When the ſmall ſtar has moſt longitude, the maximum and minimum, as well as the time of obſervation, will be the reverſe of the former. When the ſtars differ in latitudes, this makes no alteration in the place of the maximum or minimum, nor in the time of obſervation; i. e. it is immaterial whether the largeſt ſtar has the leaſt or the greateſt diſtance of the two ſtars.

Chap. VI. *Of the Figure of the Earth.*

Having now deſcribed the apparent motions of the heavenly bodies, let us return to the earth, in order to examine the information which has been collected concerning its figure.

269 Earth ſpherical.

We have ſeen already, that the earth is ſpherical. The force of *gravity* conſtantly directed towards its centre retains bodies on its ſurface, though ſituated on places diametrically oppoſite, or though *antipodes* to each other. The ſun and ſtars appear always *above* the earth; for *above* and *below* are merely relative to the direction of gravity.

270 Dimenſions how aſcertained.

As ſoon as the ſpherical figure of the earth was diſcovered, curioſity naturally led men to endeavour to meaſure its dimenſions. Hence it is probable, that attempts of that nature were made in very ancient times. The reference which ſeveral of the ancient meaſures have to the ſize of the globe is a confirmation of this. But among the moderns Picard was the firſt who executed the taſk with any degree of ſucceſs. He meaſured a degree of the meridian in France about the middle of the 17th century,

Since a meridian, or any other circle on a ſphere, may be conceived to be divided into 360 equal parts, called degrees, and theſe into minutes and ſeconds, as explained by the writers on trigonometry, the circumference of the earth, and thence its diameter, may be determined by meaſuring the length of a degree on the meridian or any other great circle. To perform this important problem, there have been various methods invented by different philoſophers of early and later times; one of theſe methods, which unites conſiderable accuracy with great facility, will be readily underſtood from fig. 95. where PB and ST repreſent two mountains or very high buildings, the diſtance PS between which muſt be very nicely determined by longimetry: then, by meaſuring the angles RBT and RTB with an accurate inſtrument, their ſum taken from 180° leaves the angle BRT, which is meaſured alſo by the arc PS; whence PS is known in parts of the whole circle. Thus, if the angle BTR be 89° 45′ 32″, the angle TBR 89° 54′ 28″, and the diſtance PS $23\frac{1}{15}$ Engliſh miles; then the angle R or arc PS being equal to $180° - \overline{89°\,45'\,32'' + 89°\,54'\,28''} = 20'$, it will be, as $20' : 60'$ or $1° :: 23\frac{1}{15} : 69\frac{1}{5}$ Engliſh miles, length of a degree. Hence the circumference of the earth is (according to this example) 24912 miles, and its diameter nearly 7930 miles.—A material advantage attending this method is, that there is no occaſion to meaſure the altitudes of the mountains, an object which can ſeldom be attained without conſiderable difficulty.

The method which is given above is, it muſt be confeſſed, as well as all the other methods which aim at the meaſurement of a degree without having recourſe to the heavenly bodies, liable to ſome inaccuracy; for, by reaſon of the changes in the ſtate of the atmoſphere, diſtant terreſtrial objects never appear in their true places; they always ſeem more or leſs elevated or diſtant, according to the nature of the ſeaſon, and the time of the day. On this account—and becauſe it could not eſcape obſervation, that as perſons changed their ſituation on the earth by moving towards the north or the ſouth, the ſtars and other heavenly bodies either increaſed or decreaſed their apparent altitudes proportionally—the meaſurement of a degree was attempted, even by the earlieſt philoſophers, by means of known fixed ſtars. Every perſon who is acquainted with plane trigonometry will admit, that the diſtance of two places, north and ſouth of each other, may be accurately meaſured by a ſeries of triangles; for if we meaſure the diſtance of any two objects, and take the angles which each of them make with a third, the triangle formed by the three objects will become known; ſo that the other two ſides may be as truly determined by calculation, as if they had been actually meaſured. And by making either of theſe ſides the baſe of a new triangle, the diſtances of other objects may be found in the ſame manner; and thus by a ſeries of triangles, properly connected at their baſes, we might meaſure any part of the circumference of the earth. And if theſe diſtances were reduced to the north and ſouth, or meridian line, and the altitude of ſome ſtar was meaſured at the extremities of the diſtance,

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distance, the difference of the altitudes would be equal to the length of the grand lines in degrees, minutes, &c. whence the length of a degree would be known. This method was, we believe, first practised by Eratosthenes in Egypt; and has been frequently used since with greater and greater accuracy, in proportion as the instruments for taking angles became, by gradual improvements, more exact and minute.

By this method, or some others not widely different, and which it is needless here to explain, the length of a degree has been measured in different parts of the earth; the results of the most noted of these admeasurements it may be proper to give.

271 Different measurements.

Snell found the length of a degree by two different methods: by one method he made it 57064 Paris toises, or 342384 feet; and by the other 57057 toises, or 342342 feet.

M. Picard, in 1669, found by mensuration from Amiens to Malvoisin, the quantity of a degree to be 57060 toises, or 342360 feet; being nearly an arithmetical mean between the numbers of Snell.

Our countryman Norwood, about the year 1635, by measuring between London and York, determined a degree at 367196 English feet, or 57300 Paris toises, or 69 miles 288 yards.

Muschenbroek, in 1700, with a view of correcting the errors of Snell, found by particular observations that the degree between Alcmaer and Bergen-op-zoom contained 57033 toises.

Messrs. Maupertuis, Clairaut, Monnier, and others from France, were sent on a northern expedition, and began their operations in July 1736; they found the length of a degree in Sweden to be 57439 toises, when reduced to the level of the sea. About the same time Messrs. Godin, Bouguer, and Condamine, from France, with some philosophers from Spain, were sent to South America, and measured a degree in the province of Quito in Peru; the medium of their results gives about 56750 toises for a degree.

M. de la Caille, being at the Cape of Good Hope in 1752, found the length of a degree on the meridian there to be 57037 toises. In 1755 Father Boscovich found the length of a degree between Rome and Rimini in Italy to be 56972 toises.

In 1764, F. Beccaria measured a degree near Turin; from his measurement he deduced the length of a degree there 57024 toises. At Vienna the length of a degree was found 57091 toises.

And in 1766 Messrs. Mason and Dixon measured a degree in Maryland and Pennsylvania, North America, which they determined to be 363763 English feet, or $56904\frac{1}{2}$ Paris toises.

The difference of these measures leads us to conclude that the earth is not exactly spherical, but that its axis which passes through the poles, is shorter than that which passes through the equator. But the observations which have been made to determine the magnitude and figure of the earth, have not hitherto led to results completely satisfactory. They have indeed demonstrated the compression or oblateness of the terrestrial spheroid, but they have left an uncertainty as to the quantity of that compression, extending from about the 170th, to the 330th part of the radius of the equator. Between these two quantities, the former of which is nearly double of the latter, most of the results are placed, but in such a manner that those best entitled to credit are much nearer to the least extreme than to the greatest. Sir Isaac Newton, as is well known, supposing the earth to be of uniform density, assigned for the compression at the poles $\frac{1}{230}$, nearly a mean between the two limits just mentioned; and it is probable, that, if the compression is less than this, it is owing to the increase of the density toward the centre. Boscovich, taking a mean from all the measures of degrees, so as to make the positive and negative errors equal, found the difference of the axis of the meridian $= \frac{1}{248}$. By comparing the degrees measured by Father Leisganic in Germany, with eight others that have been measured in different latitudes, La Lande finds $\frac{1}{311}$, and, suppressing the degree in Lapland, which appears to err in excess, $\frac{1}{331}$ for the compression. La Place makes it $\frac{1}{321}$; Sejour $\frac{1}{307}$, and, lastly, Carouge and La Lande $\frac{1}{300}$.

These anomalies have induced some astronomers, especially M. de la Place, to give up the spheroidal figure of the earth altogether, to suppose that it is not a solid of revolution, and that its surface is a curve of double curvature. Mr Playfair, on the other hand, in an excellent dissertation on the subject, published in the fifth volume of the Edinburgh Transactions, supposes, that the anomalies may be owing to the different densities of the strata near the surface where the degrees were measured, occasioning errors in the measurement. 272 Supposed figure of the earth.

273 Latitudes and longitudes how found.

The position of the different places on the earth's surface is determined by their distance from the equator, called their *latitude*, and from a first meridian called their *longitude*. The latitude is easily ascertained by observing the height of the pole: The longitude is calculated by observing some celestial phenomenon, as an eclipse of Jupiter's satellites at the same instant in two places situated in different meridians. The difference in point of apparent time in the two places, gives their distance east or west from each other, and consequently the difference of their longitude; for it is not noon at the same time in all the different parts of the earth's surface. When it is noon at London, it is only eleven o'clock in all the places 15° west from London, while it is one o'clock in all places 15° east from London. Every 15° east or west causes the difference of an hour. Hence the difference in time, when any celestial phenomenon is observed, gives us the distance east and west, or in longitude, between the places where it is observed.

The eclipses of Jupiter's satellites are of the greatest service in determining the longitudes of places on this earth, astronomers therefore have been at great pains to calculate tables for the eclipses of these satellites by their primary, for the satellites themselves have never been observed to eclipse one another. The construction

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tion of such tables is indeed much easier for these satellites than of any other celestial bodies, as their motions are much more regular.

The English tables are calculated for the meridian of Greenwich, and by these it is very easy to find how many degrees of longitude any place is distant either east or west from Greenwich; for, let an observer, who has these tables, with a good telescope and a well-regulated clock at any other place of the earth, observe the beginning or ending of an eclipse of one of Jupiter's satellites, and note the precise moment of time that he he saw the satellite either immerge into, or emerge out of, the shadow, and compare that time with the time shown by the tables for Greenwich: then 15 degrees difference of longitude being allowed for every hour's difference of time, will give the longitude of that place from Greenwich; and if there be any odd minutes of time, for every minute a quarter of a degree, east or west, must be allowed, as the time of observation is later or earlier than the time shown by the tables. Such eclipses are very convenient for this purpose at land, because they happen almost every day; but are of no use at sea, because the rolling of the ship hinders all nice telescopical observations.

Fig. 96.

To explain this by a figure, let J be Jupiter, K, L, M, N, his four satellites in their respective orbits, 1, 2, 3, 4; and let the earth be at F (suppose in November, although that month is no otherwise material than to find the earth readily in this scheme, where it is shown in eight different parts of the orbit). Let Q be a place on the meridian of Greenwich, and R a place on some other meridian eastward from Greenwich. Let a person at R observe the instantaneous vanishing of the first satellite K into Jupiter's shadow, suppose at three o'clock in the morning; but by the tables he finds the immersion of that satellite to be at midnight at Greenwich; he then can immediately determine, that as there are three hours difference of time between Q and K, and that R is three hours forwarder in reckoning than Q, it must be 45 degrees of east longitude from the meridian of Q. Were this method as practicable at sea as at land, any sailor might almost as easily, and with equal certainty, find the longitude as the latitude.

From its impracticability, the seaman is obliged to have recourse to other celestial phenomena, and the most useful are the motions of the moon. On this subject, we shall satisfy ourselves with inserting the following observations of Mr Lowe, who has pointed out a very simple method of ascertaining the longitude on land.

Philosophical Magazine, vol. xv. p. 97.

274
Mr Lowe's method of finding the longitude.

Although the method of determining the difference of longitude at sea from the lunar observations has been accurately laid down by Dr Maskelyne and other able nautical astronomers, it has, however, happened that several writers on longitude and astronomy have, in the course of the last twenty years, given rules for finding the difference of longitude at land from the moon's transits, either so erroneous or imperfect, that the adoption thereof might do a serious injury both to navigation and geography: they have given examples, but no demonstrations; or at least such obscure and imperfect ones, as prove that they had not a clear conception of the matter.

It is for these reasons that the following demonstration of a rule both easy and accurate for finding the difference of longitude is now proposed. The data are the observed increase of the moon's right ascension in passing from the first to the second meridian, and the increase of the sun's and moon's right ascension in twelve hours apparent time, which may be had from the Nautical Almanack.

Fig. 97.

Demonstration.—Let the circle ABC represent the equator, P its pole, and APD the first meridian, as that of Greenwich. Suppose that the centres of the sun, the moon, and a fixed star, are on that meridian at the same moment of time as represented at A, and that they move from thence to the westward with their respective velocities, the earth being considered as at rest. Then, after twelve hours apparent time, the sun will be at D, the opposite point to A, or 180° distant from it; but the fixed star, moving in appearance over a greater space than 180° in twelve hours apparent time, will be at E; while the moon, with a motion apparently slower than the sun and the star, will appear after twelve hours at the point B, or on a meridian BP. But ED is the distance of the sun from the star after an interval of twelve hours apparent time, and EB the distance of the moon, or, in other words, the increase of their respective right ascensions: and since ED and EB are known from the Nautical Almanack, if we subtract the first from the last, we have DB, equal to the difference between the increase of the sun's and moon's right ascension in twelve hours apparent time. Now the difference of longitude between the two meridians AP and BP is the arc AβB, equal to AβD less the arc DB; that is, equal to 180° less the difference between the increase of the sun's and moon's right ascension in twelve hours; and, since the increase of the moon's right ascension from the time of its passing the meridian AP to the time of its passing BP is known from observation, and equal to EB, we can make the following proportion for finding the difference of longitude between any other two meridians, AP and βP, from the observed increase of the moon's right ascension $\epsilon\beta$.

As EB : AβD—DB : : $\epsilon\beta$: Aβ the difference of longitude; or, in more familiar language, as the increase of the moon's right ascension in twelve hours apparent time is to 180° or 12 h. less the difference between the increase of the sun's and moon's right ascension in that time : : so is any other observed increase of the moon's right ascension between two meridians : to their difference of longitude.

If the increase of the moon's right ascension in 12 hours were uniform, or such that equal parts of it would be produced in equal times, the above rule would be strictly accurate; but as that increase arises from a motion continually accelerated or retarded, and seldom uniform but for a short space of time, it will therefore be necessary to find the mean increase of the moon's right ascension when it is at the intermediate point between A and β, in order to determine their difference of longitude with the greatest precision; and for that purpose, Taylor's Tables of Second Difference are very useful.

Example.—April the 8th, 1800, the transit of the moon's first limb was observed at the royal observatory (A); and, allowance being made for the error of the clock, its right aſcenſion was

	H. M. Sec.
	12 35 18.22
Add the time that the moon's ſemidiameter took to paſs the meridian	0 1 8.38
Right aſcenſion of the moon's centre	12 36 26.6
On a meridian (β) far to the weſtward the tranſit of the moon's firſt limb was obſerved the ſame day, and being reduced to the centre, its right aſcenſion was - - -	12 47 56.7
Increaſe of right aſcenſion between A and β - - -	0 11 30.1
The increaſe of the moon's right aſcenſion in 12 hours apparent time per the Nautical Almanac was -	0 26 3
The increaſe of the ſun's in the ſame time - - - -	0 1 49.65
Difference - - -	0 24 13.35

And 12 hours minus this difference is = 11 h. 35 m. 46.65 ſec.; therefore, as 26 m. 3 ſec. : 11 h. 35 m. 46.65 ſec. : : 11 m. 30.1 ſec. to 5 h. 7 m. 12 ſec. the correct difference of longitude between A and β.

By reducing the three terms to ſeconds, and uſing logarithms, the operation is much ſhortened.

In a book publiſhed by Mr Mackay on longitude about 15 or 16 years ago, there is a rule given, and alſo an example, for finding the difference of longitude at land from the tranſits of the moon, but no demonſtration. The rule, when diveſted of its high-ſounding enunciation, runs thus:

As the increaſe of the moon's right aſcenſion in 12 hours apparent time : is to 180° : : ſo is any other obſerved increaſe between two meridians : to their difference of longitude. It follows from this, that the moon as well as the ſun would, in 12 hours apparent time, paſs over an arc of 180°, although the apparent motion of the moon to the weſtward in 12 hours, or 180° of ſpace, be leſs than that of the ſun by ſix or ſeven degrees; and ſo much error would this method produce, if the two places differed about 180° in longitude.

The above example, wrought according to Mackay's rule, would come out thus:

	H. M. Sec.
As 26 m. 3 ſec. : 12 h. : : 11 m. 30.1 ſec. to	5 17 53.7
But the correct difference as above is	5 7 12
Error - - -	0 10 41.7

which amounts to more than $2\frac{1}{2}°$, or 150 miles, in a difference of longitude little exceeding five hours.

Mr Edward Pigot adopts the very ſame rule for determining the difference of longitude between Greenwich and York, and ſtates the reſult in the Philoſophical Tranſactions for 1786, p. 417.

Mr Vince has inſerted this rule and example in his Treatiſe of Practical Aſtronomy; but we have to regret that they were not accompanied with a ſtrict demonſtration.

The Rev. Mr Wollaſton, in the appendix to his *Faſciculus Aſtronomicus*, publiſhed two or three years ago, has given a rule, without demonſtration or example, for finding the difference of longitude from the moon's tranſits, which produces the ſame error as Mackay's and Pigot's, although worded differently from theirs. Mr Wollaſton makes the firſt term of his proportion apparent, and the third mean time; this renders the reſult erroneous. Since the motion of the ſun, moon, and planets are computed for apparent time, and given ſo in the Nautical Almanack, mean time is not at all requiſite for reſolving the difference of longitude either at ſea or at land. We ſhall therefore endeavour to apply Mr Wollaſton's rule, according to its literal meaning, for finding the difference of longitude from the above obſervations.

The right aſcenſion of the moon's centre on the meridian of Greenwich being known, we can eaſily deduce the mean and apparent time correſponding to it; and in like manner the mean and apparent time at the diſtant meridian β. The apparent and mean time of the tranſits of the moon's centre over the meridians of A and β, when ſtrictly computed, were as follows:

	Apparent Time. H. M. Sec.	*Mean Time.* H. M. Sec.
At A - -	11 26 47.81	11 28 33.5
At β - -	11 37 29.5	11 39 11.4
Time later at β than at A	0 10 41.69	0 10 37.9
From the increaſe of the moon's right aſcenſion in 12 hours -	26 3	
Subtract the increaſe of the ſun's right aſcenſion in that time -	1 49.65	
The moon's retardation in 12 hours -	24 13.35	

Then, "As twice the moon's retardation in 12 hours : is to 24 hours : :

"So is the mean time later at β than at A : to the difference of longitude weſt from A."

After doubling 24 m. 13.35 ſec. and alſo 12, which is totally unneceſſary, as the reſult would be the ſame if they ſtood the ſingle, we ſtate the following proportion:

As 48 m. 26.7 ſec. : 24 h. : : 10 m. 37.9 ſec. to 5 h. 15 m. 1.3 ſec. the difference of longitude between A and β.

But as the third term is improperly reduced to mean time, we ſhall take the apparent time above found, and then 48 m. 26.7 ſec. : 24 h. : : 10 m. 41.69 ſec. to 5 h. 17 m. 53.7 ſec.; the ſame as reſults from Mackay's and Pigot's rules.

We ſhall only remark, that 5 h. 17 m. 53.7 ſec. is the apparent time that the moon took in paſſing from the meridian of A to the meridian of β; but from what has been demonſtrated, the apparent time at β will be equal to the difference between the increaſe of the ſun's and moon's right aſcenſion in that interval of apparent time; for DB, or 24 m. 13.35 ſec. is the difference for 12 hours, and therefore by proportion ∂β, or 10 m. 41.69 ſec. will be the difference for 5 h. 17 m. 53.7 ſec.; ſubtracting the former from the latter, we have 5 h. 7 m. 12 ſec. the difference of longitude as before, and

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a clear proof that the authors above mentioned have omitted to deduct the apparent time at the distant place or station , from the apparent time at Greenwich.

A very important fact relative to the earth has been ascertained by astronomers, namely, that the weight of bodies does not continue the same when carried to different parts of it. It is impossible to ascertain this variation by the balance, because it affects equally the bodies weighed and the weight by which we estimate its gravity. But the pendulum affords a certain method of detecting every such change; because the number of oscillations made by a given pendulum in a given time depends upon the force of gravity. The smaller that force, the fewer vibrations will it make. Therefore, if the force of gravity diminish, the pendulum will move slower; if it increases, it will oscillate with more celerity. In different pendulums the slowness of vibration is proportional to the length of the pendulum: If a pendulum be lengthened it moves slower, if it be shortened it moves swifter than before. Mr Richer in a voyage made to Cayenne, found that the pendulum of his clock did not vibrate so frequently there, as it did when at Paris; but that it was necessary to shorten it by about the eleventh part of an inch to make it vibrate in exact seconds. The nearer the equator a pendulum is placed it vibrates the slower, the nearer the pole it is placed it vibrates the faster. Hence it follows that the force of gravity is greatest at the poles, and that it gradually diminishes as we approach the equator, where it is smallest.

Part III. OF THE REAL MOTIONS OF THE HEAVENLY BODIES.

We have now enumerated and explained the apparent motions of the heavenly bodies. Nothing can appear more intricate and perplexed, or more remote from what we are accustomed to consider as the simplicity of nature. Hence mankind have in all ages been tempted to consider them as merely apparent and not real; and the object of astronomers has always been to detect the real motions of the heavenly bodies from those which they exhibit to the eye of a spectator on the earth. Neither industry nor address was spared to gain this desirable end. Hypothesis was formed after hypothesis; every new supposition was a step towards the truth; and at last the real motions have not only been ascertained but demonstrated in the most satisfactory manner. It shall be our object in this part of our treatise to lay before our readers the result of these discoveries.

Chap. I. *Of the Rotation of the Earth.*

We find that the sun, and those planets on which there are visible spots, turn round their axis: for the spots move regularly over their disks (b). From hence we may reasonably conclude, that the other planets on which we see no spots, and the earth, which is likewise a planet, have such rotations. But being incapable of leaving the earth, and viewing it at a distance, and its rotation being smooth and uniform, we can neither see it move on its axis as we do the planets, nor feel our-

275 Argument for the earth's motion from its spheroidal figure.

selves affected by its motion. Yet there is one effect of such a motion, which will enable us to judge with certainty whether the earth revolves on its axis or not. All globes which do not turn round their axis will be perfect spheres, on account of the equality of the weight of bodies on their surfaces; especially of the fluid parts. But all globes which turn on their axis will be oblate spheroids; that is, their surfaces will be higher or farther from the centre in the equatorial than in the polar regions; for as the equatorial parts move quickest, they will recede farthest from the axis of motion, and enlarge the equatorial diameter. That our earth is really of this figure, is demonstrable from the unequal vibrations of a pendulum, and the unequal lengths of degrees in different latitudes. Since then the earth is higher at the equator than at the poles, the sea, which naturally runs downward, or toward the places which are nearest the centre, would run towards the polar regions, and leave the equatorial parts dry, if the centrifugal force of these parts, by which the waters were carried thither, did not keep them from returning. The earth's equatorial diameter is 36 miles longer than its axis.

Bodies near the poles are heavier than those towards the equator, because they are nearer the earth's centre, where the whole force of the earth's attraction is accumulated. They are also heavier, because their centrifugal force is less, on account of their diurnal motion being slower. For both these reasons, bodies carried from the poles towards the equator gradually lose their weight. Experiments prove, that a pendulum which vibrates seconds near the poles vibrates slower near the equator, which shows that it is lighter or less attracted there. To make it oscillate in the same time, it is found necessary to diminish its length. By comparing the different lengths of pendulums swinging seconds at the equator and at London, it is found that a pendulum must be $2\frac{169}{1000}$ lines shorter at the equator than at the poles. A line is a twelfth part of an inch.

276 Weight of bodies increases towards the poles.

If the earth turned round its axis in 84 minutes 43 seconds, the centrifugal force would be equal to the power of gravity at the equator; and all bodies there would entirely lose their weight. If the earth revolved quicker, they would all fly off and leave it.

A person on the earth can no more be sensible of its undisturbed motion on its axis, than one in the cabin of

(b) This, however, must be understood with some degree of limitation, as will evidently appear from what has been already said concerning the variable motion both of the spots of the sun and planets.

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of a ſhip on ſmooth water can be ſenſible of the ſhip's motion, when it turns gently and uniformly round. It is therefore no argument againſt the earth's diurnal motion, that we do not feel it; nor is the apparent revolutions of the celeſtial bodies every day a proof of the reality of theſe motions; for whether we or they revolve, the appearance is the very ſame. A perſon looking through the cabin windows of a ſhip, as ſtrongly fancies the objects on land to go round when the ſhip turns as if they were actually in motion.

277 Earth's motion proved from the celeſtial appearances from different planets.

If we could tranſlate ourſelves from planet to planet, we ſhould ſtill find that the ſtars would appear of the ſame magnitudes, and at the ſame diſtances from each other, as they do to us here; becauſe the width of the remoteſt planet's orbit bears no ſenſible proportion to the diſtance of the ſtars. But then the heavens would ſeem to revolve about very different axes; and conſequently, thoſe quieſcent points, which are our poles in the heavens, would ſeem to revolve about other points, which, though apparently in motion as ſeen from the earth, would be at reſt as ſeen from any other planet. Thus the axis of Venus, which lies at right angles to the axis of the earth, would have its motionleſs poles in two oppoſite points of the heavens lying almoſt in our equinoctial, where the motion appears quickeſt, becauſe it is ſeemingly performed in the greateſt circle: and the very poles, which are at reſt to us, have the quickeſt motion of all as ſeen from Venus. To Mars and Jupiter the heavens appear to turn round with very different velocities on the ſame axis, whoſe poles are about 23½ degrees from ours. Were we on Jupiter, we ſhould be at firſt amazed at the rapid motion of the heavens; the ſun and ſtars going round in 9 hours 56 minutes. Could we go from thence to Venus, we ſhould be as much ſurpriſed at the ſlowneſs of the heavenly motions; the ſun going but once round in 584 hours, and the ſtars in 540. And could we go from Venus to the moon, we ſhould ſee the heavens turn round with a yet ſlower motion; the ſun in 708 hours, the ſtars in 655. As it is impoſſible theſe various circumvolutions in ſuch different times, and on ſuch different axes, can be real, ſo it is unreaſonable to ſuppoſe the heavens to revolve about our earth more than it does about any other planet. When we reflect on the vaſt diſtance of the fixed ſtars, to which 190,000,000 of miles, the diameter of the earth's orbit, is but a point, we are filled with amazement at the immenſity of the diſtance. But if we try to frame an idea of the extreme rapidity with which the ſtars muſt move, if they move round the earth in 24 hours, the thought becomes ſo much too big for our imagination, that we can no more conceive it than we do infinity or eternity. If the ſun was to go round the earth in 24 hours, he muſt travel upwards of 300,000 miles in a minute: but the ſtars being at leaſt 400,000 times as far from the ſun as the ſun is from us, thoſe about the equator muſt move 400,000 times as quick. And all this to ſerve no other purpoſe than what can be as fully and much more ſimply obtained by the earth's turning round eaſtward as on an axis, every 24 hours, cauſing thereby an apparent diurnal motion of the ſun weſtward, and bringing about the alternate returns of day and night.

278 Another objection anſwered.

As to the common objections againſt the earth's motion on its axis, they are all eaſily anſwered and ſet aſide. That it may turn without being ſeen or felt by us to do ſo, has been already ſhown. But ſome are apt to imagine, that if the earth turns eaſtward (as it certainly does if it turns at all), a ball fired perpendicularly upward in the air muſt fall conſiderably weſtward of the place it was projected from. The objection which at firſt ſeems to have ſome weight, will be found to have none at all, when we conſider that the gun and ball partake of the earth's motion; and therefore the ball being carried forward with the air as quick as the earth and air turn, muſt fall down on the ſame place. A ſtone let fall from the top of a mainmaſt, if it meets with no obſtacle, falls on the deck as near the foot of the maſt when the ſhip ſails as when it does not. If an inverted bottle full of liquor be hung up to the ceiling of the cabin, and a ſmall hole be made in the cork, to let the liquor drop through on the floor, the drops will fall juſt as far forward on the floor when the ſhip ſails as when it is at reſt. And gnats or flies can as eaſily dance among one another in a moving cabin as in a fixed chamber. As for thoſe Scripture expreſſions which ſeem to contradict the earth's motion, this general anſwer may be made to them all, viz. It is plain from many inſtances, that the Scriptures were never intended to inſtruct us in philoſophy or aſtronomy; and therefore on thoſe ſubjects expreſſions are not always to be taken in the literal ſenſe, but for the moſt part as accommodated to the common apprehenſions of mankind. Men of ſenſe in all ages, when not treating of the ſciences purpoſely, have followed this method: and it would be in vain to follow any other in addreſſing ourſelves to the vulgar, or bulk of any community.

CHAP. II. *Of the Revolution of the Planets round the Sun.*

THE apparent motions of the planets lead us to conclude that they all move in orbits nearly circular round the ſun, while the ſun moves round the earth: that the orbits of Venus and Mercury are nearer the ſun than the earth; but the orbits of the other planets include the earth within them. All the apparent motions are reconcilable to this opinion, and lead us to form it. It removes all the inexplicable intricacy of their apparent motions.

But the earth itſelf is a planet, and bears a very exact reſemblance to the reſt. Shall we ſuppoſe all the other planets to revolve round the ſun while it alone remains ſtationary? Or ſhall we ſuppoſe that the earth, like the other planets, revolves round the ſun in the courſe of a year? The phenomena in both caſes will be exactly the ſame, but the motion of the earth will reduce the whole ſyſtem to the greateſt ſimplicity, whereas the motion of the ſun carrying with it the revolving planets would leave the whole complicated and involved. Various opinions on this ſubject have been maintained by aſtronomers.

Concerning the opinion of the very firſt aſtronomers about the ſyſtem of nature, we are neceſſarily as ignorant as we are of thoſe aſtronomers themſelves. Whatever opinions are handed down to us, muſt be of a vaſtly later date than the introduction of aſtronomy among mankind. If we may hazard a conjecture, however, we are inclined to think that the firſt opinions

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on this subject were much more just than those that were held afterwards for many ages. We are told that Pythagoras maintained the motion of the earth, which is now universally believed, but at that time appears to have been the opinion of only a few detached individuals of Greece. As the Greeks borrowed many things from the Egyptians, and Pythagoras had travelled into Egypt and Phenice, it is probable he might receive an account of this hypothesis from thence: but whether he did so or not, we have now no means of knowing, neither is it of any importance whether he did or not. Certain it is, however, that this opinion did not prevail in his days, nor for many ages after. In the 2d century after Christ, the very name of the Pythagorean hypothesis was suppressed by a system erected by the famous geographer and astronomer Claudius Ptolemæus. This system, which commonly goes by the name of the *Ptolemaic*, he seems not to have originally invented, but adopted as the prevailing one of that age; and perhaps made it somewhat more consistent than it was before. He supposed the earth at rest in the centre of the universe. Round the earth, and the nearest to it of all the heavenly bodies, the moon performed its monthly revolutions. Next to the moon was placed the planet Mercury; then Venus; and above that the sun, Mars, Jupiter, and Saturn, in their proper orbits; then the sphere of the fixed stars; above these, two spheres of what he called *crystalline* heavens; above these was the primum mobile, which, by turning round once in 24 hours, by some unaccountable means or other, carried all the rest along with it. This primum mobile was encompassed by the empyrean heaven, which was of a cubic form, and the seat of angels and blessed spirits. Besides the motions of all the heavens round the earth once in 24 hours, each planet was supposed to have a particular motion of its own; the moon, for instance, once in a month, performed an additional revolution, the sun in a year, &c. See fig. 98.

279 Pythagorean system.

280 Suppressed by the Ptolemaic.

281 Ptolemy's system insufficient.

It is easy to see, that, on this supposition, the confused motions of the planets already described could never be accounted for. Had they circulated uniformly round the earth, their apparent motion ought always to have been equal and uniform, without appearing either stationary or retrograde in any part of their courses. In consequence of this objection, Ptolemy was obliged to invent a great number of circles, interfering with each other, which he called *epicycles* and *eccentrics*. These proved a ready and effectual salvo for all the defects of his system; as, whenever a planet was deviating from the course it ought on his plan to have followed, it was then only moving in an epicycle or an eccentric, and would in due time fall into its proper path. As to the natural causes by which the planets were directed to move in these epicycles and eccentrics, it is no wonder that he found himself much at a loss, and was obliged to have recourse to divine power for an explanation, or in other words, to own that his system was unintelligible.

282 Pythagorean system revived by Copernicus.

This system continued to be in vogue till the beginning of the 16th century, when Nicolaus Copernicus, a native of Thorn (a city of Regal Prussia), and a man of great abilities, began to try whether a more satisfactory manner of accounting for the apparent motions of the heavenly bodies could not be obtained than was afforded by the Ptolemaic hypothesis. He had recourse to every author upon the subject, to see whether any had been more consistent in explaining the irregular motions of the stars than the mathematical schools: but he received no satisfaction, till he found first from Cicero, that Nicetas the Syracusan had maintained the motion of the earth; and next from Plutarch, that others of the ancients had been of the same opinion. From the small hints he could obtain from the ancients, Copernicus then deduced a most complete system, capable of solving every phenomenon in a satisfactory manner. From him this system hath ever afterwards been called the *Copernican*, and is represented fig. 99. Here the sun is supposed to be in the centre; next him revolves the planet Mercury; then Venus; next, the Earth, with the Moon: beyond these, Mars, Jupiter, and Saturn; and far beyond the orbit of Saturn, he supposed the fixed stars to be placed, which formed the boundaries of the visible creation.

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283 Tychonic system.

Though this hypothesis afforded the only natural and satisfactory solution of the phenomena which so much perplexed Ptolemy's system, it met with great opposition at first; which is not to be wondered at, considering the age in which he lived. Even the famous astronomer Tycho Brahe could never assent to the earth's motion, which was the foundation of Copernicus's scheme. He therefore invented another system, whereby he avoided the ascribing of motion to the earth, and at the same time got clear of the difficulties with which Ptolemy was embarrassed. In this system, the earth was supposed the centre of the orbits of the sun and moon; but the sun was supposed to be the centre of the orbits of the five planets; so that the sun with all the planets were by Tycho Brahe supposed to turn round the earth, in order to save the motion of the earth round its axis once in 24 hours. This system was never much followed, the superiority of the Copernican scheme being evident at first sight. Fig. 100.

The sun is so immensely bigger and heavier than the earth, that, if he was moved out of his place, not only the earth, but all the other planets, if they were united into one mass, would be carried along with the sun as the pebble would be with the mill-stone.

284 From the proportional decrease of gravity, &c.

By considering the law of gravitation, which takes place throughout the solar system, in another light, it will be evident that the earth moves round the sun in a year, and not the sun round the earth. It has been observed, that the power of gravity decreases as the square of the distance increases; and from this it follows with mathematical certainty, that when two or more bodies move round another as their centre of motion, the squares of their periodic times will be to one another in the same proportion as the cubes of their distances from the central body. This holds precisely with regard to the planets round the sun, and the satellites round the planets; the relative distances of all which are well known. But, if we suppose the sun to move round the earth, and compare its period with the moon's by the above rule, it will be found that the sun would take no less than 173,510 days to move round the earth; in which case our year would be 475 times as long as it now is. To this we may add, that the aspects of increase and decrease of the planets, the times of their seeming to stand still, and to move direct and retrograde, answer precisely to the earth's motion; but

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but not at all to the ſun's without introducing the moſt abſurd and monſtrous ſuppoſitions, which would deſtroy all harmony, order, and ſimplicity, in the ſyſtem. Moreover, if the earth be ſuppoſed to ſtand ſtill, and the ſtars to revolve in free ſpaces about the earth in 24 honrs, it is certain that the forces by which the ſtars revolve in their orbits are not directed to the earth, but to the centres of the ſeveral orbits; that is, of the ſeveral parallel circles which the ſtars on different ſides of the equator deſcribe every day; and the like inferences may be drawn from the ſuppoſed diurnal motion of the planets, ſince they are never in the equinoctial but twice in their courſes with regard to the ſtarry heavens. But, that forces ſhould be directed to no central body, on which they phyſically depend, but to innumerable imaginary points in the axis of the earth produced to the poles of the heavens, is an hypotheſis too abſurd to be allowed of by any rational creature. And it is ſtill more abſurd to imagine that theſe forces ſhould increaſe exactly in proportion to the diſtances from this axis; for this is an indication of an increaſe to infinity; whereas the force of attraction is found to decreaſe in receding from the fountain from whence it flows. But the farther any ſtar is from the quieſcent pole, the greater muſt be the orbit which it deſcribes; and yet it appears to go round in the ſame time as the neareſt ſtar to the pole does. And if we take into conſideration the twofold motion obſerved in the ſtars, one diurnal round the axis of the earth in 24 hours, and the other round the axis of the ecliptic in 25,920 years, it would require an explication of ſuch a perplexed compoſition of forces, as could by no means be reconciled with any phyſical theory.

285 Objections againſt the earth's motion anſwered.

The ſtrongeſt objection that can be made againſt the earth's motion round the ſun is, that in oppoſite points of the earth's orbit, its axis, which always keeps a parallel direction, would point to different fixed ſtars; which is not found to be fact. But this objection is eaſily removed, by conſidering the immenſe diſtance of the ſtars in reſpect of the diameter of the earth's orbit; the latter being no more than a point when compared to the former. If we lay a ruler on the ſide of a table, and along the edge of the ruler view the top of a ſpire at ten miles diſtance; then lay the ruler on the oppoſite ſide of the table in a parallel ſituation to what it had before, and the ſpire will ſtill appear along the edge of the ruler; becauſe our eyes, even when aſſiſted by the beſt inſtruments, are incapable of diſtinguiſhing ſo ſmall a change at ſo great a diſtance.

286 Earth's motion demonſtrated from the aberration of light.

Dr Bradley, our late aſtronomer-royal, found by a long ſeries of the moſt accurate obſervations, that there is a ſmall apparent motion of the fixed ſtars, occaſioned by the aberration of their light; and ſo exactly anſwering to an annual motion of the earth, as evinces the ſame, even to a mathematical demonſtration. He conſidered this matter in the following manner: he imagined CA, fig. 101. to be a ray of light falling perpendicularly upon the line BD; that, if the eye is at reſt at A, the object muſt appear in the direction AC, whether light be propagated in time or in an inſtant. But if the eye is moving from B towards A, and light is propagated in time, with a velocity that is to the velocity of the eye as CA to BA; then light moving from C to A, whilſt the eye moves from B to A, that particle of it by which the object will be diſcerned when the eye comes to A, is at C when the eye is at B. Joining the points BC, he ſuppoſed the line CB to be a tube, inclined to the line BD in the angle DBC, of ſuch diameter as to admit but one particle of light. Then it was eaſy to conceive, that the particle of light at C, by which the object muſt be ſeen, when the eye, as it moves along, arrives at A, would paſs through the tube BC, if it is inclined to BD, in the angle DBC, and accompanies the eye in its motion from B to A; and that it could not come to the eye placed behind ſuch a tube, if it had any other inclination to the line BD. If, inſtead of ſuppoſing CB ſo ſmall a tube, we imagine it to be the axis of a larger; then, for the ſame reaſon, the particle of light at C would not paſs through the axis, unleſs it is inclined to BD in the angle CBD. In like manner, if the eye moved the contrary way, from D towards A, with the ſame velocity, then the tube muſt be inclined in the angle BCD. Although, therefore, the true or real place of an object is perpendicular to the line in which the eye is moving, yet the viſible place will not be ſo; ſince that, no doubt, muſt be in the direction of the tube; but the difference between the true and apparent place will be *cæteris paribus* greater or leſs, according to the different proportion between the velocity of light and that of the eye. So that, if we could ſuppoſe that light was propagated in an inſtant, then there would be no difference between the real and viſible place of an object, although the eye was in motion; for in that caſe, AC being infinite with reſpect to AB, the angle ACB, the difference between the true and viſible place, vaniſhes. But if light be propagated in time, it is evident, from the foregoing conſiderations that there will be always a difference between the real and viſible place of an object, unleſs the eye is moving either directly towards or from the object. And in all caſes the ſine of the difference between the real and viſible place of the object will be to the ſine of the viſible inclination of the object to the line in which the eye is moving, as the velocity of the eye is to the velocity of light.

He then ſhows, that if the earth revolve round the ſun annually, and the velocity of light be to the velocity of the earth's motion in its orbit, as 1000 to 1, that a ſtar really placed in the very pole of the ecliptic would, to an eye carried along with the earth, ſeem to change its place continually; and, neglecting the ſmall difference on the account of the earth's diurnal revolution on its axis, would ſeem to deſcribe a circle round that pole every way diſtant from it $3\frac{1}{2}$; ſo that its longitude would be varied through all the points of the ecliptic every year, but its latitude would always remain the ſame. Its right aſcenſion would alſo change, and its declination, according to the different ſituation of the ſun with reſpect to the equinoctial points, and its apparent diſtance from the north pole of the equator, would be 7′ leſs at the autumnal than at the vernal equinox.

287 Velocity of light.

By calculating exactly the quantity of aberration of the fixed ſtars from their place, he found that light came from the ſun to us in 8′ 13″; ſo that its velocity is to the velocity of the earth in its orbit as 10.201 to 1.

288 Errors in the obſervation of ſmall angles.

It muſt here be taken notice of, however, that Mr Nevil Maſkelyne, in attempting to find the parallax of Sirius,

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Sirius, with a ten-feet sector, observed, that by the friction of the plummet-line on the pin which suspended it, an error of 10″, 20″, and sometimes 30″, was committed. The pin was $\frac{1}{25}$ of an inch diameter; and though he reduced it to $\frac{1}{70}$ of an inch, the error still amounted to 3″. All observations, therefore, that have hitherto been made in order to discover the parallax of the fixed stars are to be disregarded.

289 Another objection against the earth's motion answered.

It is also objected, that the sun seems to change his place daily, so as to make a tour round the starry heavens in a year. But whether the sun or earth moves, this appearance will be the same; for when the earth is in any part of the heavens, the sun will appear in the opposite. And therefore this appearance can be no objection against the motion of the earth.

It is well known to every person who has sailed on smooth water, or been carried by a stream in a calm, that, however fast the vessel goes, he does not feel its progressive motion. The motion of the earth is incomparably more smooth and uniform than that of a ship, or any machine made and moved by human art; and therefore it is not to be imagined that we can feel its motion.

290 Diurnal motion of the earth, and different changes of the seasons illustrated by experiment. Fig. 102.

The following experiment will give a plain idea of the diurnal or annual motions of the earth, together with the different lengths of days and nights, and all the beautiful variety of seasons, depending on those motions.

Take about seven feet of strong wire, and bend it into a circular form, as a b *c* d, which being viewed obliquely, appears elliptical, as in the figure. Place a lighted candle on a table; and having fixed one end of a silk thread K to the north pole of a small terrestrial globe H, about three inches diameter, cause another person to hold the wire circle, so that it may be parallel to the table, and as high as the flame of the candle I, which should be in or near the centre. Then having twisted the thread as towards the left hand, that by untwisting it may turn the globe round eastward, or contrary to the way that the hands of a watch move, hang the globe by the thread within this circle, almost contiguous to it; and as the thread untwists, the globe (which is enlightened half round by the candle as the earth is by the sun) will turn round its axis, and the different places upon it will be carried through the light and dark hemispheres, and have the appearance of a regular succession of days and nights, as our earth has in reality by such a motion. As the globe turns, move your hand slowly, so as to carry the globe round the candle according to the order of the letters a b *c* d, keeping its centre even with the wire circle; and you will perceive, that the candle, being still perpendicular to the equator, will enlighten the globe from pole to pole in its whole motion round the circle; and that every place on the globe goes equally through the light and the dark, as it turns round by the untwisting of the thread, and therefore has a perpetual equinox. The globe thus turning round, represents the earth turning round its axis: and the motion of the globe round the candle represents the earth's annual motion round the sun; and shows, that if the earth's orbit had no inclination to its axis, all the days and nights of the year would be equally long, and there would be no different seasons. Hence also it appears why the planets Mars and Jupiter have a perpetual equinox, namely, because their axis is perpendicular to the plane of their orbit, as the thread round which the globe turns in this experiment is perpendicular to the plane of the area enclosed by the wire.—But now desire the person who holds the wire to hold it obliquely in the position ABCD, raising the side ♋ just as much as he depresses the side ♑, that the flame may be still in the plane of the circle; and twisting the thread as before, that the globe may turn round its axis the same way as you carry it round the candle, that is, from west to east; let the globe down into the lowermost part of the wire circle at ♑: and if the circle be properly inclined, the candle will shine perpendicularly on the tropic of Cancer; and the frigid zone, lying within the arctic or north polar circle, will be all in the light, as in the figure; and will keep in the light, let the globe turn round its axis ever so often. From the equator to the north polar circle, all the places have longer days and shorter nights; but from the equator to the south polar circle, just the reverse. The sun does not set to any part of the north frigid zone, as shown by the candle's shining on it, so that the motion of the globe can carry no place of that zone into the dark; and at the same time the south frigid zone is involved in darkness, and the turning of the globe brings none of its places into the light. If the earth were to continue in the like part of its orbit, the sun would never set to the inhabitants of the north frigid zone, nor rise to those of the south. At the equator it would be always equal day and night; and as places are gradually more and more distant from the equator towards the arctic circle, they would have longer days and shorter nights; whilst those on the south side of the equator would have their nights longer than their days. In this case, there would be continual summer on the north side of the equator, and continual winter on the south side of it.

But as the globe turns round its axis, move your hand slowly forward, so as to carry the globe from H towards E, and the boundary of light and darkness will approach towards the north pole, and recede towards the south pole; the northern places will go through less and less of the light, and the southern places through more and more of it; showing how the northern days decrease in length and the southern days increase, whilst the globe proceeds from H to E. When the globe is at E, it is at a mean state between the lowest and highest parts of its orbit; the candle is directly over the equator, the boundary of light and darkness just reaches to both the poles, and all places on the globe go equally through the light and dark hemispheres, showing that the days and nights are then equal at all places of the earth, the poles only excepted; for the sun is then setting to the north pole and rising to the south pole.

Continue moving the globe forward, and as it goes through the quarter A, the north pole recedes still farther into the dark hemisphere, and the south pole advances more into the light, as the globe comes nearer to ♋: and when it comes there at F, the candle is directly over the tropic of Capricorn; the days are at the shortest and nights at the longest, in the northern hemisphere, all the way from the equator to the arctic circle; and the reverse in the southern hemisphere from the equator to the antarctic circle; within which circles

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circles it is dark to the north frigid zone, and light to the south.

Continue both motions; and as the globe moves through the quarter B, the north pole advances towards the light, and the south pole recedes towards the dark; the days lengthen in the northern hemisphere and shorten in the southern; and when the globe comes to G, the candle will be again over the equator (as when the globe was at E), and the days and nights will again be equal as formerly; and the north pole will be just coming into the light, the south pole going out of it.

Thus we see the reason why the days lengthen and shorten from the equator to the polar circles every year; why there is sometimes no day or night for many turnings of the earth, within the polar circles; why there is but one day and one night in the whole year at the poles; and why the days and nights are equally long all the year round at the equator, which is always equally cut by the circle bounding light and darkness.

The inclination of an axis or orbit is merely relative, because we compare it with some other axis or orbit which we consider as not inclined at all. Thus, our horizon being level to us, whatever place of the earth we are upon, we consider it as having no inclination; and yet, if we travel 90 degrees from that place, we shall then have an horizon perpendicular to the former; but it will still be level to us.

291 Different seasons particularly explained.

Let us now take a view of the earth in its annual course round the sun, considering its orbit as having no inclination; and its axis as inclining $23\frac{1}{2}$ degrees from a line perpendicular to the plane of its orbit, and keeping the same oblique direction in all parts of its annual course; or, as commonly termed, keeping always parallel to itself.

Fig. 102.

Let *a*, *b*, *c*, *d*, *e*, *f*, *g*, *h*, be the earth in eight different parts of its orbit, equidistant from one another; N*s* its axis, N its north pole, *s* its south pole, and S the sun nearly in the centre of the earth's orbit. As the earth goes round the sun according to the order of the letters *abcd*, &c. its axis N*s* keeps the same obliquity, and is still parallel to the line MN*s*. When the earth is at *a*, its north pole inclines towards the sun S, and brings all the northern places more into the light, than at any other time of the year. But when the earth is at *e* in the opposite time of the year, the north pole declines from the sun, which occasions the northern places to be more in the dark than in the light, and the reverse at the southern places; as is evident by the figure which is taken from Dr Long's astronomy. When the earth is either at *c* or *g*, its axis inclines not either to or from the sun, but lies sidewise to him, and then the poles are in the boundary of light and darkness; and the sun, being directly over the equator, makes equal day and night at all places. When the earth is a *b*, it is half-way between the summer solstice and harvest equinox; when it is at *d*, it is half-way from the harvest equinox to the winter solstice; at *f*, half-way from the winter solstice to the spring equinox; and at *h*, half-way from the spring equinox to the summer solstice.

From this oblique view of the earth's orbit, let us suppose ourselves to be raised far above it, and placed just over its centre S, looking down upon it from its north pole; and as the earth's orbit differs but very little from a circle, we shall have its figure in such a view represented by the circle ABCDEFG. Let us suppose this circle to be divided into 12 equal parts, called *signs*, having their names affixed to them; and each sign into 30 equal parts, called *degrees*, numbered 10, 20, 30, as in the outermost circle of the figure, which represents the great ecliptic in the heavens. The earth is shown in eight different positions in this circle; and in each position Æ is the equator, T the tropic of Cancer, the dotted circle the parallel of London, U the arctic or north polar circle, and P the north pole, where all the meridians or hour-circles meet. As the earth goes round the sun, the north pole keeps constantly towards one part of the heavens, as it keeps in the figure towards the right-hand side of the place.

Fig. 103.

When the earth is at the beginning of Libra, namely on the 20th of March, in this figure the sun S as seen from the earth, appears at the beginning of Aries in the opposite part of the heavens, the north pole is just coming into the light, and the sun is vertical to the equator; which, together with the tropic of Cancer, parallel of London, and arctic circle, are all equally cut by the circle bounding light and darkness, coinciding with the six o'clock hour-circle, and therefore the days and nights are equally long at all places: for every part of the meridian ÆTL*a* comes into the light at six in the morning, and, revolving with the earth according to the order of the hour-letters, goes into the dark at six in the evening. There are 24 meridians or hour-circles drawn on the earth in this figure, to show the time of sun-rising and setting at different seasons of the year.

As the earth moves in the ecliptic according to the order of the letters ABCD, &c. through the signs Libra, Scorpio, and Sagittarius, the north pole P comes more and more into the light; the days increase as the nights decrease in length, at all places north of the equator Æ; which is plain by viewing the earth at *b* on the 5th of May, when it is in the 15th degree of Scorpio, and the sun as seen from the earth appears in the 15th degree of Taurus. For then the tropic of Cancer T is in the light from a little after five in the morning till almost seven in the evening; the parallel of London, from half an hour past four till half an hour past seven; the polar circle U, from three till nine; and a large tract round the north pole P has day all the 24 hours, for many rotations of the earth on its axis.

When the earth comes to *c* (fig. 104.) at the beginning of Capricorn, and the sun as seen from the earth appears at the beginning of Cancer, on the 21st of June, as in this figure, it is in the position C in fig. 103; and its north pole inclines towards the sun, so as to bring all the north frigid zone into the light, and the northern parallels of latitude more into the light than the dark from the equator to the polar circle: and the more so as they are farther from the equator. The tropic of Cancer is in the light from five in the morning till seven at night, the parallel of London from a quarter before four till a quarter after eight; and the polar circle just touches the dark, so that the sun has only the lower half of his disk hid from the inhabitants on that circle for a few minutes about midnight;

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night, ſuppoſing no inequalities in the horizon, and no refractions.

A bare view of the figure is enough to ſhow, that as the earth advances from Capricorn towards Aries, and the ſun appears to move from Cancer towards Libra, the north pole recedes from the light, which cauſes the days to decreaſe and the nights to increaſe in length, till the earth comes to the beginning of Aries, and then they are equal as before; for the boundary of light and darkneſs cuts the equator and all its parallels equally or in halves. The north pole then goes into the dark, and continues therein until the earth goes half-way round its orbit; or, from the 23d of September till the 20th of March. In the middle between theſe times, viz. on the 22d of December, the north pole is as far as it can be in the dark, which is $23\frac{1}{2}$ degrees, equal to the inclination of the earth's axis from a perpendicular to its orbit: and then the northern parallels are as much in the dark as they were in the light on the 21ſt of June; the winter nights being as long as the ſummer days, and the winter days as ſhort as the ſummer nights. Here it muſt be noted, that of all that has been ſaid of the northern hemiſphere, the contrary muſt be underſtood of the ſouthern; for on different ſides of the equator the ſeaſons are contrary, becauſe, when the northern hemiſphere inclines towards the ſun, the ſouthern declines from him.

292 Effects of the earth's motion on the appearances of the planets.

Taking it for granted, then, that the earth revolves round the ſun, let us ſee what effect that motion has upon the apparent motions of the other planets. For the better comprehending of theſe motions, however, we have hitherto ſuppoſed the earth to ſtand ſtill in ſome part of its orbit, while they go round the ſun in theirs: but as this is not the caſe, it now remains to conſider the changes which take place in conſequence of the earth's motion. Were the earth to ſtand ſtill in any part of its orbit as at A, the places of conjunction both in the ſuperior and inferior ſemicircle, as alſo of the greateſt elongation; and conſequently the places of direct and retrograde motion, and of the ſtations of an inferior planet, would always be in the ſame part of the heavens. Thus, in fig. 105. upon this ſuppoſition, the places of Mercury's ſtations would always be the points P and R, the arc of his motion PR, and of his retrograde motion RP; whereas, on account of the earth's motion, the places where theſe appearances happen are continually advancing forward in the ecliptic according to the order of the ſigns. In fig. 106. let ABCD be the orbit of the earth; *efgh* that of Mercury; ☉ the ſun; GKI an arc of the ecliptic extended to the fixed ſtars. When the earth is at A, the ſun's geocentric place is at F; and Mercury, in order to a conjunction, muſt be in the line AF; that is, in his orbit he muſt be at *f* or *h*. Suppoſe him to be at *f* in his inferior ſemicircle: if the earth ſtood ſtill at A, his next conjunction would be when he is in his ſuperior ſemicircle at *h*; the places of his greateſt elongation alſo would be at *e* and *g*, and in the ecliptic at E and G: but ſuppoſing the earth to go on in its orbit from A to B; the ſun's geocentric place is now at K; and Mercury, in order to be in conjunction, ought to be in the line BK at *m*. As by the motion of the earth, the places of Mercury's conjunctions with the ſun are thus continually carried round in the ecliptic in conſequence, ſo the places of his utmoſt elongations muſt be carried in conſequence alſo. Thus, when the earth is at A, the places of his greateſt elongation from the ſun are in the ecliptic E and G; the motion of the earth from A to B advances them forward from G to L and from E to I. But the geocentric motion of Mercury will beſt be ſeen in fig. 107. Here we have part of the extended ecliptic marked ♈, ♉, ♊, &c. in the centre of which S repreſents the ſun, and round him are the orbits of Mercury and the earth. The orbit of Mercury is divided into 11 equal parts, ſuch as he goes through once in eight days; and the diviſions are marked by numeral figures 1, 2, 3, &c. Part of the orbit of the earth is likewiſe divided into 22 equal arcs, each arc being as much as the earth goes through in eight days. The points of diviſion are marked with the letters *a*, *b*, *c*, *d*, *e*, *f*, &c. and ſhow as many ſeveral ſtations from whence Mercury may be viewed from the earth. Suppoſe then the planet to be at 1 and the earth at *a*; draw a line from *a* to 1, and it ſhows Mercury's geocentric place at A. In eight days he will be got to 2, and the earth to *b*; draw a line 2 to *b*, and it ſhows his geocentric place at B. In other eight days he will have proceeded to 3, and the earth to *c*; a line drawn from 3 to *c* will ſhow his geocentric place at C. In this manner, going through the figure, and drawing lines from the earth at *d*, *e*, *f*, *g*, &c. through 4, 5, 6, 7, &c. we ſhall find his geocentric places ſucceſſively at the points D, E, F, G, &c. where we may obſerve, that from A to B, and from B to C, the motion is direct; from C to D, and from D to E, retrograde. In this figure 22 ſtations are marked in the earth's orbit, from whence the planet may be viewed; correſponding to which there ought to be as many in the orbit of Mercury: and for this purpoſe the place of that planet is marked at the end of every eight days for two of his periodical revolutions; and to denote this, two numeral figures are placed at each diviſion.

The geocentric motion of Venus may be explained in a ſimilar manner; only as the motion of Venus is much ſlower than that of Mercury, his conjunctions, oppoſitions, elongations, and ſtations, all return much more frequently than thoſe of Venus.

To explain the ſtationary appearances of the planets, it muſt be remembered, that the diameter of the earth's orbit, and even of that of Saturn, are but mere points in compariſon of the diſtance of the fixed ſtars; and therefore, any two lines, abſolutely parallel, though drawn at the diſtance of the diameter of Saturn's orbit from each other, would, if continued to the fixed ſtars, appear to us to terminate in the ſame point. Let, then, the two circles, fig. 108. repreſent the orbits of Venus and of the Earth; let the lines AE, BF, CG, DH, be parallel to SP, we may nevertheleſs affirm, that if continued to the diſtance of the fixed ſtars, they would all terminate in the ſame point with the line SP. Suppoſe, then, Venus at E while the earth is at A, the viſual ray by which ſhe is ſeen is the line AE. Suppoſe again, that while Venus goes from E to F, the Earth goes from A to B, the viſual ray by which Venus is now ſeen is BF parallel to AE; and therefore Venus will be all that time ſtationary, appearing in that point of the heaven where SP extended would terminate: this ſtation is at her changing from direct to retrograde. Again, ſuppoſe, when the Earth is at C,

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C, Venus is at G, and the viſual line CG; if, while the Earth goes from C to D, Venus goes from G to H, ſo that ſhe is ſeen in the line GH parallel to CG, ſhe will be all that time ſtationary, appearing in the point where a line drawn from S through P would terminate. This ſtation is at her changing from retrograde to direct; and both are in her inferior ſemicircle.

293 Perigee and apogee of the planets explained.

An inferior planet, when in conjunction with the ſun in its inferior ſemicircle, is ſaid to be in *perigee*, and in the other in *apogee*, on account of its different diſtances from the earth. Their real diſtances from the earth when in perigee are variable, partly owing to the eccentricities of their orbits, as well as that of the earth; and partly owing to the motions of the different bodies, by which it happens that they are in perigee in different parts of their orbits. The leaſt poſſible diſtance is when the perigee happens when the earth is in its perihelion, and the planet in its aphelion.

294 Differences in the apparent diameters of the planets.

The difference of diſtance between the earth and inferior planets at different times, makes a conſiderable variation in their apparent diameters, which indeed is very obſervable in all the planets; and thus they ſometimes look very conſiderably larger than at others. This difference in magnitude in Mercury is nearly at $5\frac{1}{2}$ to 1; and in Venus, no leſs than 32 to 1. A common ſpectator, unaſſiſted by any inſtrument, may obſerve an inferior planet alternately approach nearer and nearer the ſun, until at laſt it comes into conjunction with him, and then to recede farther and farther till it is at its greateſt elongation, which will be firſt on one ſide and then on the other: but if we obſerve the apparent change of place of an inferior planet in the ſphere of the heavens, its direct motions, ſtations, and retrogradations, meaſuring its diameter frequently with the micrometer, we ſhall find by its decreaſe at ſome times and increaſe at others, that its diſtance from us is very conſiderably varied; ſo that, taking the whole of its courſe into conſideration, it appears to move in a very complicated curve. See fig. 109.

295 Appearances of the ſuperior planets explained.

As the ſuperior planets move in a larger orbit than the earth, they can only be in conjunction with the ſun when they are on that ſide oppoſite to the earth; as, on the other hand, they are in oppoſition to him when the earth is between the ſun and them. They are in quadrature with him when their geocentric places are 90° diſtant from that of the ſun. In order to underſtand their apparent motions, we ſhall ſuppoſe them to ſtand ſtill in ſome part of their orbit while the earth makes a complete revolution in hers; in which caſe, any ſuperior planet would then have the following appearances: 1. While the earth is in her moſt diſtant ſemicircle, the motion of the planet will be direct. 2. While the earth is in her neareſt ſemicircle, the planet will be retrograde. 3. While the earth is near thoſe places of its orbit where a line drawn from the planet would be a tangent, it would appear to be ſtationary. Thus, in fig. 147. let *a b c d* repreſent the orbit of the earth; S the Sun; EFG an arc of the orbit of Jupiter; ABC an arc of the ecliptic projected on the ſphere of the fixed ſtars. Suppoſe Jupiter to continue at F, while the earth goes round in her orbit according to the order of the letters *a b c d*. While the earth is in the ſemicircle moſt diſtant from Jupiter, going from *a* to *b* and from *b* to *c*, his motion in the heaven would appear direct, or from A to B and from B to C: but while the earth is in its neareſt ſemicircle *c d e*, the motion of Jupiter would appear retrograde from C to B and from B to A; for *a*, *b*, *c*, *d*, may be conſidered as ſo many different ſtations from whence an inhabitant of the earth would view Jupiter at different ſeaſons of the year, and a ſtraight line drawn from each of theſe ſtations, through F the place of Jupiter, and continued to the ecliptic, would ſhow his apparent place there to be ſucceſſively at A, B, C, B, A. While the earth is near the points of contact *a* and *c*, Jupiter would appear ſtationary, becauſe the viſual ray drawn through both planets does not ſenſibly differ from the tangent F*a* or F*c*. When the earth is at *b*, a line drawn from *b* through S and F to the ecliptic, ſhows Jupiter to be in conjunction with the ſun at B. When the earth is at *d*, a line drawn from *d* through S, continued to the ecliptic, would terminate in a point oppoſite to B; which ſhows Jupiter then to be in oppoſition to the ſun: and thus it appears that his motion is direct in the conjunction, but retrograde when in oppoſition with the ſun.

The direct motion of a ſuperior planet is ſwifter the nearer it is to a conjunction, and ſlower as it approaches to a quadrature with the ſun. Thus, in fig. 111. let ⊙ be the ſun; the little circle round it, the orbit of the earth, whereof *a b c d e f g* is the moſt diſtant ſemicircle; OPQ, an arc of the orbit of Jupiter; and ABCDEFG, an arc of the ecliptic in the ſphere of the fixed ſtars. If we ſuppoſe Jupiter to ſtand ſtill at P, by the earth's motion from *a* to *g*, he would appear to move direct from A to G, deſcribing the unequal arcs AB, BC, CD, DE, EF, FG, in equal times. When the earth is at *d*, Jupiter is in conjunction with the ſun at D, and there his direct motion is ſwifteſt. When the earth is in that part of her orbit where a line drawn from Jupiter would touch it, as in the points *e* or *g*, Jupiter is nearly in quadrature with the ſun; and the nearer the earth is to any of thoſe points, the ſlower is the geocentric motion of Jupiter; for the arcs CD and DE are greater than BC or EF, and the arcs BC and EF are greater than AB or FG.

The retrograde motion of a ſuperior planet is ſwifter the nearer it is to an oppoſition, and ſlower as it approaches to a quadrature with the ſun. Thus, let ⊙, fig. 112. be the ſun; the little circle round it the orbit of the earth, whereof *g h i k l m n* is the neareſt ſemicircle; OPQ, an arc of the orbit of Jupiter; NKG an arc of the ecliptic: If we ſuppoſe Jupiter to ſtand ſtill at P, by the earth's motion from *g* to *n*, he would appear to move retrograde from G to N, deſcribing the unequal arcs GH, HI, IK, KL, LM, MN, in in equal times. When the earth is at *k*, Jupiter appears at K, in oppoſition to the ſun, and there his retrograde motion is ſwifteſt. When the earth is either at *g* or *n*, the points of contact of the tangents P*g* and P*n*, Jupiter is nearly in quadrature with the ſun: and the nearer he is to either of theſe points, the ſlower is his retrogradation; for the arcs IK and KL are greater than HI or LM; and the arcs HI and LM are greater than GH or MN. Since the direct motion is ſwifteſt

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swiftest when the earth is at *d*, and continues diminishing till it changes to retrograde, it must be insensible near the time of change: and, in like manner, the retrograde motion being swiftest when the earth is in *k*, and diminishing gradually till it changes to direct, must also at the time of that change be insensible; for any motion gradually decreasing till it changes into a contrary one gradually increasing, must at the time of the change be altogether insensible.

The same changes in the apparent motions of this planet will also take place if we suppose him to go on slowly in his orbit; only they will happen every year when the earth is in different parts of her orbit, and consequently at different times of the year. Thus, (fig. 110.) let us suppose, that while the earth goes round her orbit Jupiter goes from F to G, the points of the earth's orbit from which Jupiter will now appear to be stationary will be *a* and *y*; and consequently his stations must be at a time of the year different from the former. Moreover, the conjunction of Jupiter with the sun will now be when the earth is at *f*, and his opposition when it is at *e*; for which reason these also will happen at times of the year different from those of the preceding opposition and conjunction. The motion of Saturn is so slow, that it makes but little alteration either in the times or places of his conjunction or opposition; and no doubt the same will take place in a more eminent degree in the Georgium Sidus; but the motion of Mars is so much swifter than even that of Jupiter, that both the times and places of his conjunctions and oppositions are thereby very much altered.

Fig. 113. exemplifies the geocentric motion of Jupiter in a very intelligible manner; where ⊙ represents the sun; the circle 1, 2, 3, 4, the orbit of the earth, divided into twelve equal arcs for the twelve months of the year; PQ an arc of the orbit of Jupiter, containing as much as he goes through in a year, and divided in like manner into twelve equal parts, each as much as he goes through in a month. Now, suppose the earth to be at 1 when Jupiter is at *a*, a line drawn through 1 and *a* shows Jupiter's place in the celestial ecliptic to be at A. In a month's time the earth will have moved from 1 to 2, Jupiter from *a* to *b*; and a line drawn from 2 to *b* will show his geocentric place to be in B. In another month, the earth will be in 3, and Jupiter at C, and consequently his geocentric place will be at C; and in like manner his place may be found for the other months at D, E, F, &c. It is likewise easy to observe, that his geocentric motion is direct in the arcs AB, BC, CD, DE; retrograde in EF, FG, GH, HI; and direct again in IK, KL, LM, MN. The inequality of his geocentric motion is likewise apparent from the figure.

A superior planet is in apogee when in conjunction with the sun, and in perigee when in opposition; and every one of the superior planets is at its least possible distance from the earth where it is in perigee and perihelion at the same time. Their apparent diameters are variable, according to their distances, like those of the inferior planets; and this, as might naturally be expected, is most remarkable in the planet Mars, who is nearest us. In his nearest approach, this planet is 25 times larger than when farthest off, Jupiter twice and a half, and Saturn once and a half.

CHAP. III. *Of the Orbits of the Planets, and the Laws of their Motions.*

It would be exceedingly easy to ascertain the position of the planets for any given time, if their orbits were circular and uniform. But they exhibit very sensible inequalities in this respect, the laws of which are exceedingly important in astronomy, as furnishing the only clue which can lead us to the theory of the celestial motions. To ascertain these irregularities, and detect their laws, it is necessary to abstract from their apparent motions the effects produced by the motion of the earth. In the first place then, we must determine the nature and dimensions of the earth's orbit.

We have seen formerly that the sun apparently moves round the earth in an ellipse, having the earth in the focus. We have only to reverse the position to obtain the orbit of the earth. It moves round the sun in an ellipse, having that luminary in the focus; so that its radius vector describes areas proportional to the times. In general, all the remarks made formerly on the supposed orbit of the sun relative to its eccentricity, &c. apply accurately to the real orbit of the earth.

The figure of the earth's orbit being thus ascertained, let us see how astronomers have been able to determine that of the other planets. Let us take the planet Mars as an example, which, from the great eccentricity of its orbit, and its nearness to the earth, furnishes an excellent medium for discovering the laws of the planetary motions.

The motion of Mars round the sun and his orbit would be known, if we had at any given time, the angle formed by its radius vector, and a fixed straight line passing through the centre of the sun, together with the length of that radius vector. To simplify the problem, a time is chosen when one of these quantities may be had separately from the other. This happens at the oppositions, when we see the planet in the same point of the ecliptic to which it would be referred by a spectator in the sun. The difference in the velocity and periodic times of the earth and Mars causes the planet to appear when in opposition in different points of the ecliptic successively. By comparing together a great number of such oppositions, the relation which subsists between the time and the angular motion of Mars round the sun, (called *heliocentric*), may be discovered. Different methods present themselves for that purpose. But in the present case the problem is simplified by considering that the principal inequalities of Mars returning in the same manner at every sidereal revolution, the whole of them may be expressed by a rapidly converging series of the sines of the angles multiplied by its mean motion. The relative changes in the length of the radius vector, may be determined by comparing together observations made about the quadrature when the planet being about 90° from the sun, that radius presents itself under the greatest angle possible. In the triangle formed by the straight lines which join the centres of the earth, the sun, and Mars, the angle at the earth is obtained by observation, that at the sun is ascertained by the law of Mars's heliocentric motion. Hence the radius vector is deduced in parts of the earth's radius vector. By comparing together a number

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ber of ſuch radii vectores determined in this manner, the law of their variations, correſponding to the angles which they make with a ſtraight line fixed in poſition, may be determined. In this manner Kepler determined the orbit of Mars, and found it to be an ellipſe with the ſun in the focus. He inferred that the other planets moved likewiſe in ellipſes round the ſun, and this inference has been confirmed by actual examination.

296 Heliocentric circles of the planets.

To a ſpectator placed in the ſun, all the planets would appear to deſcribe circles annually in the heavens; for though their motions are really elliptical, the eccentricity is ſo ſmall, that the difference between them and true circles is not eaſily perceived even on earth; and at the ſun, whether great or ſmall, it would entirely vaniſh. Theſe circles, which in ſuch a ſituation would appear to be annually deſcribed among the fixed ſtars, are called the *heliocentric circles* of the planets; and if we ſuppoſe the orbits of the planets to be extended to the extreme bounds of the creation, they would deſcribe among the fixed ſtars thoſe circles juſt mentioned. To a ſpectator in the ſun, the comets, though moving in the moſt eccentric orbits, would alſo appear to deſcribe circles in the heavens: for though their orbits are in reality very long ellipſes, the planes of them extended to the heavens would mark a great circle thereon, whereof the eye would be the centre; only, as the real motion is in an ellipſis, the body would appear to move much more ſlowly in ſome part of the circle than another, and to differ exceſſively in magnitude. To an inhabitant of any planet, however, the ſun appears to go round in its own heliocentric circle, or to deſcribe in the heavens that ſame curve which the planet would appear to do if ſeen from the ſun. Thus (fig. 114.), when the earth is at *a*, if we draw a line from *a* through the ſun at S, the point G, in the ſphere of the heavens where the line terminates, is the place where the ſun then appears to an inhabitant of the earth. In a month's time the earth will be got from *a* to *b*; draw a line then through the ſun, and its extremity at H will point out his apparent place at that time. In like manner, if we draw lines from the earth in the twelve ſeveral ſituations in which it is repreſented for the twelve months of the year, the ſun's apparent place will be found as above, and ſo it would be found by a ſpectator placed in Venus or any other planet.

The geocentric latitude of a ſuperior planet may be underſtood from fig. 115. Let AB be the orbit of the earth, CD that of Mars, both viewed with the eye in their common ſection continued, by which they appear in ſtraight lines, Let E and F be oppoſite points of the ecliptic, and ſuppoſe Mars to be in the ſouth limit at C. If he were at that time viewed from S, the centre of the ſun, he would appear in the ſphere of the heavens at the point H; in which caſe his heliocentric latitude would be FH: But when viewed in C from the earth, or from its centre, which in this caſe is ſuppoſed to be the ſtation of the ſpectator, he will appear to be in different places of the heavens according to the poſition of the earth. When the earth, for inſtance, is at B, the place of Mars will appear to be at *g*, and his geocentric latitude will be F*g*. When the earth is at A, his apparent place will be in G, and his geocentric latitude FG: and in like manner, ſuppoſing the earth to be in any other part of its orbit, as in I or K, it is eaſy to ſee, that his apparent places, as well as geocentric latitudes at thoſe times, will be different.

297 Nodes of a planet.

The two points where the heliocentric circle of any planet cuts the ecliptic, are called its *nodes*; and that which the planet paſſes through as it goes into north latitude, is called the *aſcending* node, and is marked thus ☊; and the oppoſite to this is called the *deſcending* node, and is marked ☋. A line drawn from one node to the other is called the *line of the nodes of the planet*, which is the common ſection of the plane of the ecliptic, and that of the planet produced on each ſide to the fixed ſtars. The deviation of the orbit from a circle is called the *eccentricity* of the orbit; the point where it is fartheſt diſtant from the ſun is called its *aphelion*; and where neareſt, the *perihelion*.

The motion of the planets is ſwifteſt at the perihelion when the radius vector is ſhorteſt: it diminiſhes as the radius vector increaſes, and is at its minimum at the aphelion. When Kepler compared theſe two quantities in the planet Mars, he obſerved that the velocity of the planet was always proportional to the ſquare of the radius vector, ſo that the product of that velocity multiplied into the ſquare of the radius vector is a conſtant quantity. This product is double the area deſcribed by the radius vector in the given time. Hence that area, ſuppoſing the radius vector to ſet out from a fixed line, increaſes as the time. This Kepler announced by ſaying, that the areas deſcribed by the radius vector are proportional to the times. Theſe laws are preciſely thoſe followed by the earth in her motion round the ſun. Hence Kepler eſtabliſhed as the fundamental laws of the motions of the planets the two following:

1. The orbits of the planets are ellipſes, having the ſun in their focus.

2. The areas deſcribed by the radius vector of each planet are proportional to the times of deſcribing them.

Theſe laws ſuffice for determining the motions of the planets round the ſun: But it is neceſſary to know for each of the planets ſeven quantities, called the elements of their elliptical motion. Five of theſe elements relative to the motion of the ellipſe are, 1. The duration of the ſidereal revolution. 2. Half the greater axis or the mean diſtance of the planet from the ſun. 3. The eccentricity of the orbit. 4. The mean longitude of the planet at a given time. 5. The longitude of its perihelion at the ſame epoch. The other two elements relate to the poſition of the orbits. They are, 6. The longitude of the nodes of the orbit at a given epoch, or the points where the orbit interſects the ecliptic. 7. The inclination of the orbit to the plane of the ecliptic. The following table exhibits a view of theſe elements.

	Sidereal revolutions.	Mean distances.	Eccentricity in 1750.	Secular variation in the eccentricity.	Mean longitude in 1750.	Longitudes of the perihelion in 1750.	Sidereal and secular motion of the perihelion.	Inclination of the orbits to the ecliptic in 1750.	Secular variation in the inclination to the ecliptic.	Longitudes of the ascending nodes in 1750.	Sidereal and secular motion of the nodes.
	Days.				°	°	″	°	″	°	″
Mercury	87.969255	0.387100	0.205513	0.000003369	281.3194	81.7401	1735.50	7.7778	55.09	50.3836	—2332.90
Venus	224.700817	0.723332	0.006885	0.000062905	51.4963	141.9759	—699.07	3.7701	13.80	82.7093	—5673.60
Earth	365.256384	1.000000	0.016814	0.000045572	311.1218	309.5790	3671.63	0.0000	0.00	0.0000	0.00
Mars	686.979579	1.523693	0.093088	0.000090685	24.4219	368.3006	4834.57	2.0556	—4.45	52.9377	—7027.41
Jupiter	4332.602208	5.202792	0.048077	0.000134245	4.1201	11.5012	2030.25	1.4636	—67.40	108.8062	—4509.50
Saturn	10759.077213	9.540724	0.056223	0.000261553	257.0438	97.9466	4967.64	2.7762	—47.87	123.9327	—5781.54
Herſchel	30689.000000	19.183620	0.046683	0.000026228	353.9610	185.1262	759.85	0.8599	9.38	80.7015	—10608.00

The ſign — denotes a retrograde motion.

In this table, drawn up by M. de La Place, the decimal notation is employed; the circle being divided into 400°, the degree into 100′, the minute into 100″, and ſo on: we did not alter it, in order to give the reader a ſpecimen of this notation, and becauſe the uſual notation is employed in the following table.

We think it proper to ſubjoin here Dr Maſkelyne's view of the planetary ſyſtem for 1801, Dec. 1.

	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.
	Apparent mean diameters, as ſeen from the earth.	Mean diameters as ſeen from the ſun.	Mean diameters in Engliſh miles.	Mean diſtances from the ſun, in round numbers of miles.	More accurate proportional numbers of the preceding mean diſtances.	Denſities to that of water, which is 1.	Proportions of the quantities of matter.	Inclinations of orbits to the ecliptic in 1780.	Inclinations of axes to orbits.	Rotations diurnal, or round their own axes.
The Sun	32′ 1″,5		883246			$1\frac{24}{15}$	333928		82° 44′ 0″	25d 14h 8m 0s
Mercury	10	16″	3224	37000000	38710	$9\frac{1}{6}$	0,1654	7° 0′ 0″		
Venus	58	30	7687	68000000	72333	$5\frac{11}{15}$	0,8899	3 23 35		0 23 21
The Earth		17,2	7911,73	95000000	100000	$4\frac{1}{2}$	1	0 0 0	66 32	1
The Moon	31 8	4,6	2180	95000000	100000	$5\frac{1}{2}$	0,025	5 9 3 at a mean.	88 17	29 17 44 3
Mars	27	10	4189	144000000	152369	$3\frac{2}{7}$	0,0875	1 51 0	59 22	0 24 39 22
Ceres	1		160	260000000	273550			10 37 56,6 in 1801.		
Pallas	0,5		80	266000000	279100			34 50 40 in 1801.		
Jupiter	39	37	89170	490000000	520279	$1\frac{1}{24}$	312,1	1 18 56 in 1780.	90 nearly.	0 9 55 37
Saturn	18	16	79042	900000000	954072	$0\frac{13}{32}$	97,76	2 29 50 in 1780.	60 probably.	0 10 16 2
Herſchel	3 54	4	35112	1800000000	1908352	$0\frac{99}{100}$	16,84	0 46 20 in 1780.		

	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.
	Tropical revolutions.	Sidereal revolutions.	Places of Aphelia, January 1800.	Secular motions of the Aphelia.	Eccentricities; the mean distances being 100000.	Greatest equations of the centres.	Longitudes of ☊; or places of ascending nodes in 1750.	Secular motions of nodes.
The Sun								
Mercury	87d 23h 14m 32,7s	87d 23h 15m 43,6s	8s 14° 20′ 50″	1° 33′ 45″	7955·4	23° 40′ 0″	1s 15° 20′ 43″	1° 12′ 10″
Venus	224 16 41 27,5	224 16 49 10,6	10 7 59 1	1 21 0	498	0 47 20	2 14 26 18	0 51 40
The Earth	365 5 48 49	365 6 9 12	9 8 40 12	0 19 35	1681,395	1 55 30,9		
The Moon								
Mars	686 22 18 27,4	686 23 30 35,6	5 2 24 4	1 51 40	14183,7	10 40 40	1 17 38 38	0 46 40
Ceres	1681 12 9 0		10 25 57 15 in 1802.		8140,64	9 20 8	2 20 58 40 in 1802.	
Pallas		1703 16 48 0			24630		5 22 28 57 in 1802.	
Jupiter	4330 14 39 2	4332 14 27 10,8	6 11 8 20 in 1800.	1 34 33	25013,3	5 30 38	3 7 55 32 in 1750.	0 59 30
Saturn	10746 19 16 15,5	10759 1 51 11,2	8 29 4 11 in 1800.	1 50 7	53640,42	6 26 42	3 21 32 22 in 1750.	0 55 30
Herschel	30637 4 0 0	30737 18 0 0	11 16 30 31 in 1800.	1 29 2	90804	5 27 16	2 12 47 in 1788.	1 44 35

From the above tables it appears that the time of the revolution of the planets increases with their distance from the sun. This induced Kepler to suspect that some relation existed between them. After many attempts continued for 17 years, he at last discovered that the squares of the periodic times of the planets are proportional to the cubes of the greater axis of their orbits.

Chap. IV. *Of the Orbits of the Comets.*

Of all the celestial bodies, comets have given rise to the greatest number of speculations and conjectures. Their strange appearance has in all ages been a matter of terror to the vulgar, who uniformly have looked upon them to be evil omens and forerunners of war, pestilence, &c. Others, less superstitious, supposed them to be meteors raised in the higher regions of the air. But we find that some part of the modern doctrine concerning them had been received into the ancient Italic and Pythagorean schools: for they held them to be so far of the nature of planets, that they had their periodical times of appearing; that they were out of sight for a long time, while they were carried aloft at an immense distance from the earth, but became visible when they descended into the lower regions of the air, when they were nearer to us.

298 Supposed by the ancients to be planets.

These opinions were probably brought from Egypt, from whence the Greeks borrowed great part of their learning. However, it seems not to have been generally received; for Aristotle, who mentions it, asserted that the heavens were unchangeable, and not liable to generation or corruption. Comets, therefore, which he believed to be generated when they first made their appearance, and destroyed when they vanished from our sight, he maintained could not be heavenly bodies, but rather meteors or exhalations raised into the upper regions of the atmosphere, where they blazed out for a while, and disappeared when the matter of which they were formed was consumed. Seneca, who lived in the first century, mentions Apollonius of Myndus, a very careful observer of natural causes, to have been of the same sentiments with the most ancient Greek philosophers with regard to comets. He himself had seen two; one in the reign of Claudius, the other in that of Nero; besides another which he saw while a boy, before the death of Augustus. He plainly intimates, that he thought them above the moon; and argues strongly against those who supposed them to be meteors, or held other absurd opinions concerning them; declaring his belief that they were not fires suddenly kindled, but the eternal productions of nature. He points out also the only way to come at a certainty on this subject, viz. by collecting a number of observations concerning their appearance, in order to discover whether they return periodically or not. "For this purpose (says he) one age is not sufficient; but the time will come when the nature of comets and their magnitudes will be demonstrated, and the routes they take, so different from the planets, explained. Posterity will then wonder that the preceding ages should be ignorant of matters so plain and easy to be known."

299 Aristotle's opinion concerning them.

For a long time this prediction of Seneca seemed very unlikely to be fulfilled. The great authority which Aristotle maintained for many ages, determined them to be nothing but meteors casually lighted up in the air; though they were manifestly at a great height, not only above the clouds, but subject to the diurnal revolution of the earth. In the dark and superstitious ages, they were held to be the forerunners of every kind of calamity, and were supposed to have different degrees of malignity according to the shape they assumed; from whence also they were differently denominated. Thus, some were said to be bearded, some hairy; some to represent a beam, sword, or spear; others

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others a target, &c.; whereas modern aſtronomers acknowledge only one ſpecies of comets, and account for their different appearances from their different ſituations from the ſun and earth.

300 Only one ſpecies of them exiſts.

It was not till ſome time after people began to throw off the fetters of ſuperſtition and ignorance which had ſo long held them, that any rational hypotheſis was formed concerning comets.

301 Kepler and Bodin's opinion of them.

Kepler, in other reſpects a very great genius, indulged the moſt extravagant conjectures, not only concerning comets, but the whole ſyſtem of nature in general. The planets he imagined to be huge animals who ſwam round the ſun by means of certain fins acting upon the ethereal fluid, as thoſe of fiſhes do on the water: and agreeable to this notion, he imagined the comets to be monſtrous and uncommon animals generated in the celeſtial ſpaces; and he explained how the air engendered them by an animal faculty. A yet more ridiculous opinion, if poſſible, was that of John Bodin, a learned man of France in the 16th century. He maintained that comets "are ſpirits, which have lived on the earth innumerable ages, and being at laſt arrived on the confines of death, celebrate their laſt triumph, or are recalled to the firmament like ſhining ſtars! This is followed by famine, plague, &c. becauſe the cities and people deſtroy the governors and chiefs who appeaſe the wrath of God." This opinion (he ſays) he borrowed from the philoſopher Democritus, who imagined them to be the ſouls of famous heroes: but that being irreconcilable with Bodin's Chriſtian ſentiments, he was obliged to ſuppoſe them to be a kind of genii, or ſpirits ſubject to death, like thoſe ſo much mentioned in the Mahometan fables. Others, again, have denied even the exiſtence of comets, and maintained that they were only falſe appearances occaſioned by the refraction or reflection of light.

302 Bernouilli's opinion.

The firſt rational conjecture we meet with is that of James Bernouilli, an Italian aſtronomer, who imagined them to be the ſatellites of ſome very diſtant planet, which was inviſible to us on account of its diſtance, as were alſo the ſatellites, unleſs when in a certain part of their courſe.

303 True doctrine concerning them revived by Tycho Brahe.

Tycho Brahe was the firſt who reſtored the comets to their true rank in the creation. Before his time, ſeveral comets had been obſerved with tolerable exactneſs by Regiomontanus, Appian, Fabricius, and others; yet they all thought them below the moon. But Tycho, being provided with much better inſtruments, ſet himſelf with great diligence to obſerve the famous comet of 1577; and from many careful obſervations, deduced that it had no ſenſible diurnal parallax; and therefore was not only far above the regions of our atmoſphere, but much higher than the moon. But though few have come ſo near the earth as to have any diurnal parallax, all of them have what may be called an annual parallax; that is, the revolution of the earth in her orbit cauſes their apparent motion to be very different from what it would be if viewed from the ſun; and this ſhows them to be much nearer than the fixed ſtars, which have no ſuch parallax. Kepler, the diſciple of Tycho, notwithſtanding his ridiculous conjecture already mentioned, was very attentive to the motions of the comets, and found that they did not move in ſtraight lines, as had been ſuppoſed. He ſhowed that their paths were concave towards the ſun, and ſuppoſed them to move in parabolic trajectories.

304 Their motion exactly determined by Sir Iſaac Newton.

Their true motion, however, was only diſcovered from the obſervations made by Sir Iſaac Newton on the great comet of 1680. This deſcended almoſt perpendicularly towards the ſun with a prodigious velocity; aſcending again with the ſame velocity retarded, as it had been before accelerated. It was ſeen in the morning by a great number of aſtronomers in different parts of Europe, from the 4th to the 25th of November, in its way toward the ſun; and in the evening from the 12th of December to the 9th of March following. The many exact obſervations made on this comet enabled Sir Iſaac Newton to determine that they are a kind of planets which move in very eccentric ellipſes; and this opinion is now looked upon to be certainly eſtabliſhed. It was oppoſed, however, by M. de la Hire, and ſome other French philoſophers; and it is evident that the whole diſpute now turned on mere practical obſervations. If the return of any comet could be predicted, and its periodical time calculated like that of a planet, then the doctrine might be concluded certainly true, but not otherwiſe.

305 Dr Halley predicts a comet's return.

Dr Halley therefore ſet himſelf to collect all the obſervations he could on comets; and afterwards calculated the periodical times of 24 of them, on a ſuppoſition of their being paraboles; but afterwards found that they agreed better with the ſuppoſition of their motion being performed in very eccentric elliptical orbits. On this he calculated a table of their elements; from which it was manifeſt that they were not comprehended in the zodiac, ſome of them making an angle of upwards of 80° with the ecliptic.

306 Periodical times of different comets determined.

By computations founded on theſe elements, the Doctor concluded that the comet of 1682 was the ſame which had appeared in 1607 and 1531; that it had a period of 75 or 76 years; and he ventured to foretel that it would return about the year 1758. The comet which appeared in 1661 was ſuppoſed to be the ſame with that of 1532, and to have a period of 129 years; and from the equality of periods, and ſimilitude of appearances, it was concluded that the great comet of 1680 was the ſame which had appeared in 1106 in the time of Henry I. and the conſulate of Lampadius and Oreſtes about the year 531, and in the year 44 B. C. before Julius Cæſar was murdered; and thence concluded that its period was 575 years. Mr Dunthorne, however, has endeavoured to ſhow from a MS. in Pembroke-hall library, that the comet of 1106 could not be the ſame with that of 1680: but M. de Lande thinks the four appearances related by Dr Halley ſtronger proofs than a ſingle obſervation, which might be very faulty.

307 Why comets may ſometimes be inviſible even in their perihelion.

Since the time of Dr Halley, other aſtronomers have calculated the elements of 25 other comets; all of which, excepting one of three which appeared in 1759, and which differs but little from that of 1531, 1607, and 1682, and it is therefore accounted the ſame, differ very much from each other; ſo that we cannot help concluding them all to be different, and that the number of theſe bodies is very great. "It is not, however, unlikely (ſays Dr Long), from the immenſe interval between the orbit of Saturn and the neareſt fixed ſtars, that many of them have not deſcended into the planetary

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planetary regions since they have been looked upon as celestial bodies, and observed accordingly: besides, it may often happen, that a body may finish its whole period without being observed by us, on account of the unfavourable situation of the earth in her orbit when the comet is in its perihelion. Thus, if the comet be either behind or before the sun, or nearly so, it must be above our horizon in the day-time, and consequently invisible, except the sun should at that time be in a total eclipse; for then the comet might be seen near the sun, as well as the stars and planets are: and this case is said to have happened; for Seneca relates from Possidonius, that a comet was seen when the sun was eclipsed, which had before been invisible by being near that luminary."

308 Why more are seen in the hemisphere towards the sun than in the opposite.

A greater number of comets are seen in the hemisphere towards the sun than in the opposite; the reason of which will easily appear from fig. 116. wherein S represents the sun, E the earth, A B C D the sphere of the fixed stars: and because comets either do not reflect light enough to be visible, or emit tails conspicuous enough to attract our notice, till they come within the planetary regions, commonly a good way within the sphere of Jupiter, let K L M N be a sphere concentric to the sun, at such a distance from him, that no comet can be seen by us till it come within that distance; through E draw the plane B D perpendicular to S E, which will divide the sphere C L M N into two hemispheres, one of which, B C D, is toward the sun, the other, D A B, opposite. Now it is manifest, that the spherical portion L M N, which is in the hemisphere B C D towards the sun, is larger than the portion N K L in the hemisphere opposite to him; and consequently a greater number of comets will appear in the hemisphere B C D than in that marked D A B.

309 Great differences in the eccentricities of the orbits of comets.

Though the orbits of all comets are very eccentric ellipses, there are vast differences among them; excepting Mercury, there are no great differences among the planets either as to the eccentricity of their orbits, or the inclination of their planes; but the planes of some comets are almost perpendicular to others, and some of their ellipses are much wider than others. The narrowest ellipsis of any comet hitherto observed was that of 1680. There is also a much greater inequality in the motion of the comets than of the planets; the velocity of the former being incomparably greater in their perihelion than in their aphelion; but the planets are but very little accelerated.

310 Opinions concerning their substance.

Astronomers are now generally agreed, that comets are opaque bodies, enlightened by the sun. Hevelius, in a large work, wherein he gives the opinion of various authors on the subject, mentions some who were of the same sentiments with himself, that comets were so far transparent as to let the light of the sun pass thro' them, which formed their tails. Sir Isaac Newton was of opinion, that they are quite opaque; and in confirmation of this, he observes, that if a comet be seen in two parts of its orbit, at equal distances from the earth, but at unequal distances from the sun, it always shines brightest in that nearest the sun. They are of very different magnitudes, which may be conjectured from their apparent diameter and brightness. Thus the head of a comet, when of the same brightness and apparent diameter with Saturn, may be supposed to be nearly about the same magnitude with that planet; though this must be attended with some uncertainty, as we know not whether the heads of comets reflect the sun's light in the same manner the planets do. Their distance may be known from their parallax, in the manner related in a subsequent section. 311

311 Distances, diameters, &c. of some comets computed.

In this manner he found the distance of the comet of 1577 to be about 210 semidiameters of the earth, or about 840,000 miles distant from us, its apparent diameter being seven minutes; whence he concluded, that the true diameter of the comet was to that of the earth as 3 to 14. "But (says Dr Long) it was the hemisphere of the comet which was then measured." Hevelius, from the parallax and apparent diameter of the head of the comet in 1652, computed its diameter to be to that of the earth as 52 to 100. By the same method he found the diameter of the head of the comet of 1664 to be at one time 12 semidiameters of the earth, and at another not much more than 5. "That the head of the comet must appear less the farther it is from the earth (says Dr Long) is obvious; but besides this apparent change, there is also a real one in the dimensions of the head of the same comet; for, when near the sun, the atmosphere is diminished by the heat raising more of it into the tail; whereas, at a greater distance, the tail is diminished and the head enlarged." Hevelius computed the diameter of the nucleus of the comets of 1661 and 1665 to be only about a tenth part of that of the earth; and Cysatus makes the true diameter of the comet of 1618 to be about the same size. Some comets, however, from their apparent magnitude and distance, have been supposed much larger than the moon, or even equal in magnitude to some of the primary planets; and some have imagined, that by an interposition of these bodies betwixt the earth and sun, we might account for those darknesses which cannot be derived from any interposition of the moon. Such are those mentioned by Herodotus, l. 7. c. 37. and l. 9. c. 70; likewise the eclipse mentioned by Dion, which happened a little before the death of Augustus; and it is observable that Seneca saw a comet that year. Some have even attempted to account in this manner for the darkness which happened at our Saviour's crucifixion; and indeed it is certain, that were a comet in its perigee to come between the earth and sun, and to be moving the same way with the earth, it must cause a darkness much more intense, as well as of more considerable duration, than what could take place in any lunar eclipse.

312 Eclipses occasioned by comets.

313 Conjectures concerning their tails.

Various conjectures have been formed respecting the tails of comets; though it is acknowledged by all, that they depend on the sun somehow or other; and for this plain reason, that they are always turned from him; but in what manner this is accomplished, we cannot easily determine. Apian, Tycho Brahe, and others, thought the tail was formed by the sun's rays transmitted through the nucleus of the comet, which they fancied transparent, and was there refracted as in a lens of glass, so as to form a beam of light behind the comet: but this cannot be the case, as well because the figure of a comet's tail does not answer to such a refraction, as that such refracted light would not be seen by a spectator placed sideways to it, unless it fell upon some substance sufficiently dense to cause a reflection. Descartes and his followers were of opinion, that the tail of a comet was owing to the refrac- 314

314 Opinion of Descartes.

tion

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tion of its head: but if this were the caſe, the planets and principal fixed ſtars muſt have tails alſo; for the rays from them paſs through the ſame medium as the light from the comets. Sir Iſaac Newton was of opinion, that the tail of a comet is a very thin vapour which the head ſends out by reaſon of its heat: that it aſcends from the ſun juſt as ſmoke does from the earth: that as the aſcent of ſmoke is cauſed by the rarefaction of the air wherein it is entangled, cauſing ſuch air to aſcend and carry the ſmoke up with it; ſo the ſun's rays acting upon the coma or atmoſphere of the comet, do by rarefaction and refraction heat the ſame: that this heated atmoſphere heats, and by heating rarefies, the ether that is involved therein; and that the ſpecific gravity with which ſuch ether tends to the ſun, is ſo diminiſhed by its rarefaction, that it will now aſcend from him by its relative lightneſs, and carry with it the reflecting particles whereof the tail is compoſed. Tho' the immenſely large tails of ſome comets ſeem to require a great quantity of matter to produce them, this is no objection to the foregoing ſolution: for every day's experience ſhows what a great quantity of ſmoke is produced from a very little wood or coal; and Newton has demonſtrated, that a cubic inch of air equally rarefied with that at the diſtance of a ſemidiameter from the earth's ſurface, would fill all the planetary regions to the orbit of Saturn and beyond. Mairan entertained a very different opinion. He ſuppoſed the tails of the comets to be formed out of the luminous matter whereof the ſun's atmoſphere conſiſts. This he ſuppoſes to extend as far as the orbit of the earth, and to furniſh matter for the aurora borealis. M. de la Lande is for joining the two laſt opinions together. Part of the matter which forms the tails of comets he ſuppoſes to ariſe from their own atmoſphere rarefied by heat and puſhed forward by the force of the light ſtreaming from the ſun; and alſo that a comet paſſing through the ſun's atmoſphere is drenched therein, and carries away ſome of it. Mr Rowning objects to Newton's account, that it can hardly be ſuppoſed the thin vapour of the tail ſhould go before the more ſolid body of the comet, when the motion thereof is ſometimes ſo extremely ſwift, as that of ſome of the comets is ſaid to be after the rate, as Sir Iſaac Newton calculated the motion of the comet of 1680 to be, of no leſs than 880,000 miles an hour. He therefore ſuppoſes the atmoſphere of the comet to extend every way round it as far as the tail reaches; and that the part of it which makes the tail is diſtinguiſhed from the reſt, ſo as to fall thick upon that part of the atmoſphere which goes before the comet in its progreſs along its elliptic orbit. The greateſt objection to this is the immenſe magnitude of the atmoſpheres; as it muſt now be ſuppoſed to account for the vaſt lengths of the tails of ſome comets, which have been ſaid to meaſure above 80 millions of miles.

The many diſcoveries which, ſince the time of Newton, Halley, and other celebrated mathematicians, have been made in electricity, having brought in a new element unknown to former ages, and which ſhows a vaſt power through every part of the creation with which we are acquainted, it became natural to imagine that it muſt extend alſo into thoſe higher regions which are altogether inacceſſible to man. The ſimilarity of the tails of comets to the Aurora Borealis, which is commonly looked upon to be an electrical phenomenon, therefore ſuggeſted an opinion, at preſent far from being generally diſbelieved, that the tails of comets are ſtreams of electric matter. An hypothesis of this kind was publiſhed by Dr Hamilton of 315
Dublin in a ſmall treatiſe, entitled, *Conjectures on the Nature of the Aurora Borealis, and on the Tails of Comets*. His hypotheſis is, that the comets are of uſe to bring back the electric fluid to the planets, which is continually diſcharged from the higher regions of their atmoſpheres. Having given at length the above-mentioned opinion of Sir Iſaac, "We find (ſays he) in this account, that Sir Iſaac aſcribes the aſcent of comets tails to their being rarer and lighter, and moving round the ſun more ſwiftly than the ſolar atmoſphere, with which he ſuppoſes them to be ſurrounded whilſt in the neighbourhood of the ſun; he ſays alſo, that whatever poſition (in reſpect to each other) the head and tail of a comet then receive, they will keep the ſame afterwards moſt freely; and in another place he obſerves, 'That the celeſtial ſpaces muſt be entirely void of any power of reſiſting, ſince not only the ſolid bodies of the planets and comets, but even the exceeding thin vapours of which comets tails are formed, move through thoſe ſpaces with immenſe velocity, and yet with the greateſt freedom.' I cannot help thinking that this account is liable to many difficulties and objections, and that it ſeems not very conſiſtent with itſelf or with the phenomena.

Dr Hamilton of Dublin's opinion.

"I do not know that we have any proof of the exiſtence of a ſolar atmoſphere of any conſiderable extent, nor are we anywhere taught how to gueſs at the limits of it. It is evident that the exiſtence of ſuch an atmoſphere cannot be proved merely by the aſcent of comets tails from the ſun, as that phenomenon may poſſibly ariſe from ſome other cauſe. However, let us ſuppoſe for the preſent, that the aſcent of comets tails is owing to an atmoſphere ſurrounding the ſun; and ſee how the effects ariſing from thence will agree with the phenomena. When a comet comes into the ſolar atmoſphere, and is then deſcending almoſt directly to the ſun, if the vapours which compoſe the tail are raiſed up from it by the ſuperior denſity and weight of that atmoſphere, they muſt riſe into thoſe parts that the comet has left, and therefore at that time they may appear in a direction oppoſite to the ſun. But as ſoon as the comet comes near the ſun, and moves in a direction nearly at right angles with the direction of its tail, the vapours which then ariſe, partaking of the great velocity of the comet, and being ſpecifically lighter than the medium in which they move, and being vaſtly expanded through it, muſt neceſſarily ſuffer a reſiſtance immenſely greater than what the ſmall and denſe body of the comet meets with, and conſequently cannot poſſibly keep up with it, but muſt be left behind, or, as it were, driven backwards by the reſiſtance of that medium into a line directed towards the parts which the comet has left, and therefore can no longer appear in a direction oppoſite to the ſun. And, in like manner, when a comet paſſes its perihelion, and begins to aſcend from the ſun, it certainly ought to appear ever after with its tail behind it, or in a direction pointed towards the ſun; for if the tail of the comet be ſpecifically lighter than the medium in which it moves with ſo great velocity, it muſt be juſt as impoſſible

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possible it should move foremost, as it is that a torch moved swiftly through the air should project its flame and smoke before it. Since therefore we find that the tail of a comet, even when it is ascending from the sun, moves foremost, and appears in a direction nearly opposite to the sun, I think we must conclude that the comet and its tail do not move in a medium heavier and denser than the matter of which the tail consists, and consequently that the constant ascent of the tail from the sun must be owing to some other cause. For that the solar atmosphere should have density and weight sufficient to raise up the vapours of a comet from the sun, and yet not be able to give any sensible resistance to these vapours in their rapid progress through it, are two things inconsistent with each other: And therefore, since the tail of a comet is found to move as freely as the body does, we ought rather to conclude, that the celestial spaces are void of all resisting matter, than that they are filled with a solar atmosphere, be it ever so rare.

"But there is, I think, a further consideration, which will show that the received opinion, as to the ascent of comets tails, is not agreeable to the phenomena, and may at the same time lead us to some knowledge of the matter of which these tails consist; which I suspect is of a very different nature from what it has been hitherto supposed to be. Sir Isaac says, the vapours, of which the tail of a comet consists, grow hot by reflecting the rays of the sun, and thereby warm and rarefy the medium which surrounds them; which must therefore ascend from the sun, and carry with it the reflecting particles of which the tail is formed; for he always speaks of the tail as shining by reflected light. But one would rather imagine, from the phenomena, that the matter which forms a comet's tail has not the least sensible power of reflecting the rays of light. For it appears from Sir Isaac's observation, which I have quoted already, that the light of the smallest stars, coming to us through the immense thickness of a comet's tail, does not suffer the least diminution. And yet, if the tail can reflect the light of the sun so copiously as it must do if its great splendour be owing to such reflection, it must undoubtedly have the same effect on the light of the stars; that is, it must reflect back the light which comes from the stars behind it, and by so doing must intercept them from our sight, considering its vast thickness, and how exceedingly slender a ray is that comes from a small star; or if it did not intercept their whole light, it must at least increase their twinkling. But we do not find that it has even this small effect; for those stars that appear through the tail are not observed to twinkle more than others in their neighbourhood. Since therefore this fact is supported by observations, what can be a plainer proof that the matter of a comet's tail has no power of reflecting the rays of light? and consequently, that it must be a self-shining substance. But the same thing will further appear, from considering that bodies reflect and refract light by one and the same power; and therefore if comets tails want the power of refracting the rays of light, they must also want the power of reflecting them. Now, that they want this refracting power appears from hence: If that great column of transparent matter which forms a comet's tail, and moves either in a vacuum or in some medium of a different density from its own, had any power of refracting a ray of light coming through it from a star to us, that ray must be turned far out of its way in passing over the great distance between the comet and the earth; and therefore we should very sensibly perceive the smallest refraction that the light of the stars might suffer in passing through a comet's tail. The consequence of such a refraction must be very remarkable: the stars that lie near the tail would, in some cases, appear double; for they would appear in their proper places by their direct rays, and we should see their images behind the tail, by means of their rays which it might refract to our eyes; and those stars that were really behind the tail would disappear in some situations, their rays being turned aside from us by refraction. In short, it is easy to imagine what strange alterations would be made in the apparent places of the fixed stars by the tails of comets, if they had a power of refracting their light, which could not fail to be taken notice of if any such ever happened. But since astronomers have not mentioned any such apparent changes of place among the stars, I take it for granted that the stars seen through all parts of a comet's tail appear in their proper places, and with their usual colours; and consequently I infer, that the rays of light suffer no refraction in passing through a comet's tail. And thence I conclude (as before), that the matter of a comet's tail has not the power of refracting or reflecting the rays of light, and must therefore be a lucid or self-shining substance."

316 Sir Isaac's account defended.

But whatever probability the Doctor's conjecture concerning the materials whereof the tails are formed may have in it, his criticism on Sir Isaac Newton's account of them seems not to be just: for that great philosopher supposes the comets to have an atmosphere peculiar to themselves; and consequently in their nearest approaches to the sun, both comet and atmosphere are immersed in the atmosphere of that luminary. In this case, the atmosphere of the comet being prodigiously heated on the side next to the sun, and consequently the equilibrium in it broken, the denser parts will continually pour in from the regions farthest from the sun; for the same reason, the more rarefied part which is before will continually fly off opposite to the sun, being displaced by that which comes from behind; for though we must suppose the comet and its atmosphere to be heated on all sides to an extreme degree, yet still that part which is farthest from the sun will be less hot, and consequently more dense, than what is nearest to his body. The consequence of this is, that there must be a constant stream of dense atmosphere descending towards the sun, and another stream of rarefied vapours and atmosphere ascending on the contrary side; just as in a common fire there is a constant stream of dense air ascending, which pushes up another of rarefied air, flame, and smoke. The resistance of the solar atmosphere may indeed be very well supposed to occasion the curvature observable in the tails of comets, and their being better defined in the fore part than behind; and this appearance we think Dr Hamilton's hypothesis is incapable of solving. We grant, that there is the utmost probability that the tails of comets are streams of electric matter; but they who advance a theory of any kind ought to solve every phenomenon, otherwise their theory is insufficient. It was incumbent

317 Dr Hamilton's hypothesis insufficient.

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cumbent on Dr Hamilton, therefore to have explained how this ſtream of electric matter comes to be bent into a curve; and alſo why it is better defined and brighter on the outer ſide of the arch than on the inner. This, indeed, he attempts in the following manner: "But that this curvature was not owing to any reſiſting matter appears from hence, that the tail muſt be bent into a curve, though it met with no reſiſtance; for it could not be a right line, unleſs all its particles were projected in parallel directions, and with the ſame velocity, and unleſs the comet moved uniformly in a right line. But the comet moves in a curve, and each part of the tail is projected in a direction oppoſite to the ſun, and at the ſame time partakes of the motion of the comet; ſo that the different parts of the tail muſt move on in lines which diverge from each other; and a line drawn from the head of a comet to the extremity of the tail, will be parallel to a line drawn from the ſun to the place where the comet was when that part of the tail began to aſcend, as Sir Iſaac obſerves: and ſo all the chords or lines drawn from the head of the comet to the intermediate parts of the tail, will be reſpectively parallel to lines drawn from the ſun to the places where the comet was when theſe parts of the tail began to aſcend. And therefore, ſince theſe chords of the tail will be of different lengths, and parallel to different lines, they muſt make different angles with a great circle paſſing through the ſun and comet; and conſequently a line paſſing through their extremities will be a curve.

"It is obſerved, that the convex ſide of the tail which is turned from the ſun is better defined, and ſhines a little brighter, than the concave ſide. Sir Iſaac accounts for this, by ſaying, that the vapour on the convex ſide is freſher (that is, has aſcended later) than that on the concave ſide; and yet I cannot ſee how the particles on the convex ſide can be thought to have aſcended later than thoſe on the concave ſide which may be nearer to the head of the comet. I think it rather looks as if the tail, in its rapid motion, met with ſome ſlight reſiſtance juſt ſufficient to cauſe a ſmall condenſation in that ſide of it which moves foremoſt, and which would occaſion it to appear a little brighter and better defined than the other ſide; which ſlight reſiſtance may ariſe from that ſubtile ether which is ſuppoſed to be diſperſed through the celeſtial regions, or from this very electric matter diſperſed in the ſame manner, if it be different from the ether.

On the laſt part of this obſervation we muſt remark, that though a ſlight reſiſtance in the ethereal medium would have ſerved Sir Iſaac Newton's turn, it will by no means ſerve Dr Hamilton's; for though a ſtream of water or air may be eaſily deſtroyed or broken by reſiſtance, yet a ſtream of electric matter ſeems to ſet every obſtacle at defiance. If a ſharp needle is placed on the conductor of an electric machine, and the machine ſet in motion, we will perceive a ſmall ſtream of electric matter iſſuing from the point; but though we blow againſt this ſtream of fire with the utmoſt violence, it is impoſſible either to move it, or to brighten it on the ſide againſt which we blow. If the celeſtial ſpaces then are full of a ſubtile ether capable of thus affecting a ſtream of electric matter, we may be ſure that it alſo will reſiſt very violently: and we are then as much difficulted to account for the projectile motion continuing amidſt ſuch violent reſiſtance; for if the ether reſiſts the tail of the comet, it is impoſſible to prove that it doth not reſiſt the head alſo.

318 Electric matter not always paſſive.

This objection may appear to ſome to be but weakly founded, as we perceive the electric fluid to be endowed with ſuch extreme ſubtility, and to yield to the impreſſion of ſolid bodies with ſuch facility, that we eaſily imagine it to be of a very paſſive nature in all caſes. But it is certain, that this fluid only ſhows itſelf paſſive where it paſſes from one body into another, which it ſeems very much inclined to do of itſelf. It will alſo be found, on proper examination of all the phenomena, that the only way we can manage the electric fluid at all is by allowing it to direct its own motions. In all caſes where we ourſelves attempt to aſſume the government of it, it ſhows itſelf the moſt untractable and ſtubborn being in nature. But theſe things come more properly under the article ELECTRICITY, where they are fully conſidered. Here it is ſufficient to obſerve, that a ſtream of electric matter reſiſts air, and from the phenomena of electric repulſion we are ſure that one ſtream of electric matter reſiſts another: from which we may be alſo certain, that if a ſtream of electric matter moves in an aerial fluid, ſuch fluid will reſiſt it; and we can only judge of the degree of reſiſtance it meets with in the heavens from what we obſerve on earth. Here we ſee the moſt violent blaſt of air has no effect upon a ſtream of electric fluid: in the celeſtial regions, either air or ſome other fluid has an effect upon it according to Dr Hamilton. The reſiſtance of that fluid, therefore, muſt be greater than that of the moſt violent blaſt of air we can imagine.

As to the Doctor's method of accounting for the curvature of the comet's tail, it might do very well on Sir Iſaac Newton's principles, but cannot do ſo on his. There is no compariſon between the celerity with which rarefied vapour aſcends in our atmoſphere, and that whereby the electric fluid is diſcharged. The velocity of the latter ſeems to equal that of light; of conſequence, ſuppoſing the velocity of the comet to be equal to that of the earth in its annual courſe, and its tail equal in length to the diſtance of the ſun from the earth, the curvature of the tail could only be to a ſtraight line as the velocity of the comet in its orbit is to the velocity of light, which, according to the calculations of Dr Bradley, is as 10,201 to 1. The apparent curvature of ſuch a comet's tail, therefore, would at this rate only be $\frac{1}{10101}$ part of its viſible length, and this would always be imperceptible to us. The velocity of comets is indeed ſometimes inconceivably great. Mr Brydone obſerved one at Palermo, in July 1770, which in 24 hours deſcribed an arch in the heavens upwards of 50 degrees in length; according to which he ſuppoſes, that if it was as far diſtant as the ſun, it muſt have moved at the rate of upwards of 60 millions of miles in a day. But this comet was attended with no tail, ſo that we cannot be certain whether the curvature of the tails of theſe bodies correſponds with their velocity or not.

319 Prodigious velocity of a comet obſerved by Mr Brydone.

320 Vehement heat of the comet of 1680.

The near approach of ſome comets to the ſun ſubjects them to intenſe and inconceivable degrees of heat. Newton calculated that the heat of the comet of 1680 muſt have been near 2000 times as great as that of red-hot iron. The calculation is founded upon this principle,

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principle, that the heat of the ſun falling upon any body at different diſtances is reciprocally as the ſquares of thoſe diſtances; but it may be obſerved, that the effect of the heat of the ſun upon all bodies near our earth depends very much on the conſtitution of thoſe bodies, and of the air that ſurrounds them. "The comet in queſtion (ſays Dr Long) certainly acquired a prodigious heat; but I cannot think it came up to what the calculation makes it: the effect of the ſtrongeſt burning-glaſs that has ever been made uſe of was the vitrification of moſt bodies placed in its focus. What would be the effect of a ſtill greater heat we can only conjecture; it would perhaps ſo diſunite the parts as to make them fly off every way in atoms. This comet, according to Halley, in paſſing through its ſouthern node, came within the length of the ſun's ſemidiameter of the orbit of the earth. Had the earth then been in the part of her orbit neareſt to that node, their mutual gravitation muſt have cauſed a change in the plane of the orbit of the earth, and in the length of our year: he adds, that if ſo large a body, with ſo rapid a motion as that of this comet, were to ſtrike againſt the earth, a thing by no means impoſſible, the ſhock might reduce this beautiful frame to its original chaos."

We muſt not conclude this account without obſerving that Whiſton, who, from Flamſtead's meaſure of its apparent diameter, concluded the nucleus of the comet to be about ten times as big as the moon, or equal to a fourth part of the earth, attributes the univerſal deluge in the time of Noah to the near approach thereof. His opinion was, that the earth paſſing through the atmoſphere of the comet, attracted therefrom great part of the water of the flood; that the nearneſs of the comet raiſed a great tide in the ſubterraneous waters, ſo that the outer cruſt of the earth was changed from a ſpherical to an oval figure; that this could not be done without making fiſſures and cracks in it, through which the waters forced themſelves, by the hollow of the earth being changed into a leſs capacious form; that along with the water thus ſqueezed up on the ſurface of the earth, much ſlime or mud would riſe; which, together with the groſſer part of the comet's atmoſphere, would, after the ſubſiding of the water, partly into the fiſſures and partly into the lower parts of the earth to form the ſea, cover all over, to a conſiderable depth, the antediluvian earth. Thus he accounts for trees and bones of animals being found at a very great depth in the earth. He alſo held that, before the fall, the earth revolved round the ſun in the plane of the ecliptic, keeping always the ſame points of its ſurface towards the ſame fixed ſtars. By this means, as every meridian would come to the ſun but once in every revolution, a day and a year were then the ſame: but that a comet ſtriking obliquely upon ſome part of the earth gave it the diurnal rotation; that the antediluvian year conſiſted of 360 days: but that the additional matter depoſited upon the earth from the atmoſphere of the comet at the flood, ſo retarded the revolution thereof round the ſun, that it is not now performed in leſs than 365 days and about a quarter. The ſame comet he thought would probably, coming near the earth when heated in an intenſe degree in its perihelion, be the inſtrumental cauſe of that great cataſtrophe, the general conflagration, foretold in the ſacred writings and from ancient tradition.

321 Conjectures of Hevelius, &c. concerning the nature of comets.

Theſe conjectures lead us to ſpeak ſomewhat more particularly concerning the nature of comets, and the purpoſes they may poſſibly anſwer in the creation. Hevelius, in order to account for the various appearances of the nucleus already related, ſuppoſed that they were compoſed of ſeveral maſſes compacted together, with a tranſparent fluid interſperſed, but the apparent changes in the nucleus may be only on the ſurface: comets may be ſubject to ſpots as the planets are; and the vaſtly different degrees of heat they go through may occaſion great and ſudden changes, not only in their ſurfaces, but even in their internal frame and texture. Newton places all theſe apparent changes to the atmoſphere that environs them; which muſt be very denſe near their ſurfaces, and have clouds floating therein. It was his opinion, that the changes mentioned may all be in the clouds, not in the nucleus. This laſt indeed he looked upon to be a body of extreme ſolidity, in order to ſuſtain ſuch an intenſe heat as the comets are ſometimes deſtined to undergo; and that, notwithſtanding their running out into the immenſe regions of ſpace, where they were expoſed to the moſt intenſe degrees of cold, they would hardly be cooled again on their return to the ſun. Indeed, according to his calculation, the comet of 1680 muſt be for ever in a ſtate of violent ignition. He hath computed that a globe of red-hot iron of the ſame dimenſions with the earth, would ſcarce be cool in 50,000 years. If then the comet be ſuppoſed to cool 100 times faſter then red-hot iron, as its heat was 2000 times greater, it muſt require upwards of a million of years to cool it. In the ſhort period of 575 years, therefore, its heat will be in a manner ſcarce diminiſhed; and, of conſequence, in its next and every ſucceeding revolution, it muſt acquire an increaſe of heat: ſo that, ſince the creation, having received a proportional addition in every ſucceeding revolution, it muſt now be in a ſtate of ignition very little inferior to that of the ſun itſelf. Sir Iſaac Newton hath farther concluded, that this comet muſt be conſiderably retarded in every ſucceeding revolution by the atmoſphere of the ſun within which it enters; and thus muſt continually come nearer and nearer his body, till at laſt it falls into it. This, he thinks, may be one uſe of the comets, to furniſh fuel for the ſun, which otherwiſe would be in danger of waſting from the continual emiſſion of its light.

He adds, that for the conſervation of the water and moiſture of the planets, comets ſeem abſolutely requiſite; from whoſe condenſed vapours and exhalation all the moiſture which is ſpent in vegetation and putrefaction, and turned into dry earth, &c. may be reſupplied and recruited; for all vegetables grow and increaſe wholly from fluids; and again, as to their greateſt part, turn by putrefaction into earth; an earthy ſlime being perpetually precipitated to the bottom of putrefying liquors. Hence the quantity of dry earth muſt continually increaſe, and the moiſture of the globe decreaſe, and be quite evaporated, if it have not a continual ſupply from ſome part or other of the univerſe. "And I ſuſpect (adds our great author), that the ſpirit which makes the fineſt, ſubtileſt, and beſt

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part of our air, and which is abſolutely requiſite for the life and being of all things, comes principally from the comets."

322 Mr Brydone's conjectures concerning comets without tails.

Mr Brydone obſerves, that the comets without tails ſeem to be of a very different ſpecies from thoſe which have tails: To the latter, he ſays, they appear to bear a much leſs reſemblance than they do even to planets. He tells us, that comets with tails have ſeldom been viſible but on their receſs from the ſun: that they are kindled up, and receive their alarming appearance, in their near approach to this glorious luminary; but that thoſe without tails are ſeldom or ever ſeen but on their way to the ſun; and he does not recollect any whoſe return has been tolerably well aſcertained. "I remember indeed (ſays he), a few years ago, a ſmall one, that was ſaid to have been diſcovered by a teleſcope after it had paſſed the ſun, but never more became viſible to the naked eye. This aſſertion is eaſily made, and nobody can contradict it; but it does not at all appear probable that it ſhould have been ſo much leſs luminous after it had paſſed the ſun than before it approached him: and I will own to you, when I have heard that the return of theſe comets had eſcaped the eyes of the moſt acute aſtronomers, I have been tempted to think, that they did not return at all, but were abſorbed in the body of the ſun, which their violent motion towards him ſeemed to indicate." He then attempts to account for the continual emiſſion of the ſun's light without waſte, by ſuppoſing that there are numberleſs bodies throughout the univerſe that are attracted into the body of the ſun, which ſerve to ſupply the waſte of light, and which for ſome time remain obſcure and occaſion ſpots on his ſurface, till at laſt they are perfectly diſſolved and become bright like the reſt. This hypotheſis may account for the dark ſpots becoming as bright, or even brighter, than the reſt of the diſk, but will by no means account for the brighter ſpots becoming dark. Of this comet, too, Mr Brydone remarks, that it was evidently ſurrounded by an atmoſphere which refracted the light of the fixed ſtars, and ſeemed to cauſed them change their places as the comet came near them.

323 Mr Cole's hypotheſis.

A very ſtrange opinion we find ſet forth in a book entitled "Obſervations and Conjectures on the Nature and Properties of Light, and on the Theory of Comets, by William Cole." This gentleman ſuppoſes that the comets belong to no particular ſyſtem; but were originally projected in ſuch directions, as would ſucceſſively expoſe them to the attraction of different centres, and thus they would deſcribe various curves of the parabolic and the hyperbolic kind. This treatiſe is written in anſwer to ſome objections thrown out in Mr Brydone's Tour, againſt the motions of the comets by means of the two forces of gravitation and projection, which were thought ſufficient for that purpoſe by Sir Iſaac Newton: of which we ſhall treat as fully as our limits will allow in the next ſection.

324 Of the periodical times, &c. of the comets.

The analogy between the periodical times of the planets and their diſtances from the ſun, diſcovered by Kepler, takes place alſo in the comets. In conſequence of this, the mean diſtance of a comet from the ſun may be found by comparing its period with the time of the earth's revolution round the ſun. Thus the period of the comet that appeared in 1531, 1607, 1682, and 1759, being about 76 years, its mean diſtance from the ſun may be found by this proportion: As 1, the ſquare of one year, the earth's periodical time, is to 5776 the ſquare of 76, the comet's periodical time; ſo is 1,000,000, the cube of 100 the earth's mean diſtance from the ſun, to 5,776,000,000 the cube of the comet's mean diſtance. The cube root of this laſt number is 1794; the mean diſtance itſelf in ſuch parts as the mean diſtance of the earth from the ſun contains 100. If the perihelion diſtance of this comet, 58, be taken from 3588 double the mean diſtance, we ſhall have the aphelion diſtance, 3530, of ſuch parts as the diſtance of the earth contains 100; which is a little more than 35 times the diſtance of the earth from the ſun. By a like method, the aphelion diſtance of the comet of 1680 comes out 138 times the mean diſtance of the earth from the ſun, ſuppoſing its period to be 575 years: ſo that this comet, in its aphelion, goes more than 14 times the diſtance from the ſun that Saturn does. Euler computes the orbit of this comet from three of Flamſtead's obſervations taken near together, compared with a fourth taken at ſome diſtance from the other three, and from thence concludes the period to be a little more than 170 years. "It ſeems ſomething ſurpriſing (ſays Dr Long), that, from the ſame obſervations which were uſed by Newton and Halley, he ſhould bring out a period ſo very different from what theſe great men have determined: but it is the leſs to be wondered at, if we conſider how ſmall a portion of the comet's orbit lay between the moſt diſtant places uſed in this computation, or indeed that could be had for that purpoſe; ſo ſmall, that the form of the ellipſis cannot be found with preciſion by this method, except the comet's places were more exactly verified than is poſſible to be done: and that he does not pretend to confirm his determination of the period by pointing out and comparing together any former appearances of this comet; a method which Newton recommended as the only one whereby the periodical times and tranſverſe diameters of the orbits of the comets can be determined with accuracy."

The period of the comet in 1744 is much longer than even that of 1680. Mr Betts, in attempting to compute the tranſverſe axis of its orbit, found it come out ſo near infinite, that, though the orbit ſhowed itſelf in this manner to be a very long one, he found it impoſſible to calculate it without ſome obſervations made after its perihelion. Halley, after he had finiſhed his tables of comets, found ſuch a ſimilitude in the elements of thoſe of 1531, 1607, and 1682, that he was induced to believe them to be returns of the ſame comet in an elliptic orbit: but as there was ſuch a difference in their periodical times and inclinations of their orbits as ſeemed to make againſt this opinion; and as the obſervations of the firſt of them in 1531 by Appian, and the ſecond in 1607 by Kepler, were not exact enough to determine ſo nice a point when he firſt publiſhed his ſynopſis in 1705; he only mentioned this as a thing probable, and recommended it to poſterity to watch for an appearance of the ſame in 1758. Afterwards, looking over the catalogue of ancient comets, and finding three others at equal intervals with thoſe now mentioned, he grew more poſitive in his opinion; and knowing a method of calculating with eaſe a motion in an elliptic orbit, how eccentric ſoever it might be, inſtead of the parabolic orbit which he had given

325 Dr Halley calculates the return of comets.

given for the comet of 1682, he ſet about adapting the plan of that orbit to an ellipſis of a given ſpace and magnitude, having the ſun in one of its foci, ſo as to tally with the obſervations of that comet made by Flamſtead with great accuracy, by the help of a very large ſextant. He likewiſe corrected the places of the comet of 1531 from Appian, and thoſe of the comet 1607 from Kepler and Longomontanus, by rectifying the places of the ſtars they had made uſe of, and found thoſe places agree as well with the motion in ſuch an ellipſis as could be expected from the manner of obſerving of theſe aſtronomers, and the imperfections of their inſtruments. The greateſt objection to this theory was ſome difference in the inclination of the orbits, and that there was above a year's difference between the two periods. The comet of 1531 was in its perihelion Auguſt 24.; that of 1607, October 16. and that of 1682, September 4.: ſo that the firſt of theſe periods was more than 76, the latter not quite 75 years. To obviate this, he reminds his readers of an obſervation made by him of the periodical revolution of Saturn having at one time been about 13 days longer than at another time; occaſioned, as he ſuppoſed, by the near approach of Saturn and Jupiter, and the mutual attraction and gravitation of theſe two planets: and obſerves, that in the ſummer of the year 1681, the comet in its deſcent was for ſome time ſo near Jupiter, that its gravitation towards that planet was one-fiftieth part of its gravitation towards the ſun. This, he concluded, would cauſe a change in the inclination of its orbit, and alſo in the velocity of its motion: for by continuing longer near the planet Jupiter on the ſide moſt remote from the ſun, its velocity would be more increaſed by the joint forces of both thoſe bodies, than it would be diminiſhed by them acting contrarywiſe, when on the ſide next the ſun where its motion was ſwifteſt. The projectile motion being thus increaſed, its orbit would be enlarged, and its period lengthened; ſo that he thought it probable it would not return till after a longer period than 76 years, about the end of the year 1758, or beginning of 1759.

326 Why the periodical return of comets may happen at unequal intervals.

As Halley expreſſed his opinion modeſtly, though clearly enough, that this comet would appear again about the end of 1758, or the beginning of the following year, M. de la Lande pretends he muſt have been at a loſs to know whether the period he foretold would have been of 75 or of 76 years; that he did not give a deciſive prediction, as if it had been the reſult of calculation; and that, by conſidering the affair in ſo looſe a manner as Halley did, there was a good deal of room for objecting to his reaſoning. After theſe reflections, he is very large in his commendation of the performance of Clairault; who, he ſays, not only calculated ſtrictly the effect of the attraction of Jupiter in 1681 and 1683, when the comet was again near Jupiter, but did not neglect the attraction of that planet when the comet was moſt diſtant; that he conſidered the uninterrupted attractions of Jupiter and Saturn upon the ſun and upon the comet, but chiefly the attractions of Jupiter upon the ſun, whereby that luminary was a little diſplaced, and gave different elements to the orbit of the comet. By this method he found the comet would be in its perihelion about the middle of April; but that, on account of ſome ſmall quantities neceſſarily neglected in the method of approximation made uſe of by him, Mr Clairault deſired to be indulged one month; and that the comet came juſt 30 days before the time he had fixed for its appearance.

That comets may have their motion diſturbed by the planets, eſpecially by the two largeſt, Jupiter and Saturn, appears by an inſtance juſt now mentioned. They may alſo affect one another by their mutual gravitation when out of the planetary regions; but of this we can take no account, nor can we eſtimate the reſiſtance of the ether through which they paſs; and yet both theſe cauſes may have ſome influence on the inclination of their orbits and the length of their periods.

Chap. V. *Of the Motions of the Satellites.*

The moon is the ſatellite which moves round the earth, and as her apparent and real motions are the ſame, we have already given an account of her elliptical orbit and irregularities.

Jupiter is attended by four ſatellites. If we repreſent the ſemidiameters of Jupiter's equator by unity, then the mean diſtances of the ſatellites from Jupiter, will be repreſented by the following numbers.

327 Orbits and diſtances of Jupiter's ſatellites.

Firſt ſatellite	5.697300 ſemidiameters.
Second ſatellite	9.065898
Third ſatellite	14.461628
Fourth ſatellite	25.436000

The durations of their revolutions are reſpectively,

Firſt ſatellite	1.769137787069931 days.
Second ſatellite	3.551181016734509
Third ſatellite	7.154552807541524
Fourth ſatellite	16.689019396008634

If we compare the diſtances of theſe ſatellites with their periodic times, we obſerve the ſame relation pointed out by Kepler between the diſtances of the planets from the ſun and the duration of their revolutions: for the ſquares of the periodic times of the ſatellites are proportional to the cubes of their diſtance from Jupiter's centre.

The frequent eclipſes of theſe ſatellites have enabled aſtronomers to aſcertain their motion, with much more preciſion than could have been attained merely by obſerving their diſtances from Jupiter. The following points have been aſcertained.

The orbit of the firſt ſatellite is circular, at leaſt its eccentricity is inſenſible; it coincides nearly with Jupiter's equator, which is inclined to the orbit of the planet at an angle of 3.9999°.

The ellipticity of the orbit of the ſecond ſatellite is alſo inſenſible; its inclination to Jupiter's orbit varies, as does alſo the poſition of its nodes. Theſe irregularities are repreſented pretty well, by ſuppoſing the inclination of the orbit to the equator of Jupiter 1750.968″, and that its nodes move retrograde in that plane in a period of 30 years. 328 Irregularities in their motions.

A ſmall eccentricity is obſerved in the orbit of the third ſatellite. The extremity of its longer axis next Jupiter, called the *perijove*, has a direct motion. The eccentricity of the orbit has been obſerved to vary conſiderably. The equation of the centre was at its maximum about the end of the 17th century; it then amounted

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mounted to about 862″; it gradually diminiſhed, and in the year 1775 it was at its minimum, and amounted only to about 229.7″. The inclination of the orbit of this ſatellite to that of Jupiter, and the poſition of its nodes, are variable. Theſe different variations are repreſented pretty nearly, by ſuppoſing the orbit inclined to that of Jupiter, at an angle of about 726″, and giving to the nodes a retrograde motion in the plane of the equator, completed in the period of 137 years.

The orbit of the fourth ſatellite is very ſenſibly elliptical. Its perijove has a direct motion, amounting to about 2112″. This orbit is inclined to that of Jupiter, at an angle of about 147′. It is in conſequence of this inclination, that the fourth ſatellite often paſſes behind the planet relatively to the ſun without being eclipſed. From the firſt diſcovery of this planet, till the year 1760, the inclination of its orbit appeared conſtant: but it has ſenſibly increaſed ſince that period.

Beſides all theſe variations, the ſatellites of Jupiter are ſubjected to ſeveral irregularities, which diſturb their elliptical motion, and render their theory very complicated. Theſe irregularities are moſt conſpicuous in the three firſt ſatellites.

Their mean motions are ſuch, that the mean motion of the firſt ſatellite, together with twice the mean motion of the third, is nearly equal to thrice the mean motion of the ſecond. The ſame relation holds in their ſynodical motions. The mean longitude both ſynodical and ſidereal of the firſt three ſatellites, ſeen from the centre of Jupiter, is ſuch, that the longitude of the firſt, minus thrice that of the ſecond, plus twice that of the third, is nearly equal to the ſemi-circumference. This relation is ſo very near the truth, that one is tempted to conſider it as rigorous, and to aſcribe the ſuppoſed errors to the imperfection of obſervations. It will hold at leaſt for a long time to come, and ſhews us that the three ſatellites cannot be eclipſed at once.

The periods and laws of the principal irregularities of theſe ſatellites are the ſame in all. The irregularity of the firſt advances or retards its eclipſes 20″ of time at its maximum. If we compare the changes on this inequality, with the relative poſitions of the two firſt ſatellites, we find that it diſappears when theſe two ſatellites, ſeen from the centre of Jupiter, are in oppoſition at the ſame time; that it increaſes gradually, and acquires its maximum when the firſt ſatellite, at the inſtant of oppoſition, is 45° more advanced than the ſecond; that it vaniſhes when the firſt is 90° before the ſecond. Beyond that point it becomes negative and retards the eclipſes, and increaſes till the two ſatellites are 135 degrees from each other, when it acquires its negative maximum. Then it diminiſhes and diſappears when they are 180° diſtant. In the ſecond half of the circumference the very ſame laws are obſerved as in the firſt. From theſe phenomena it has been concluded, that there exiſts in the motion of the firſt ſatellite round Jupiter, an inequality amounting to 1733.6″ at its maximum, and proportional to the ſine of twice the exceſs of the mean longitude of the firſt ſatellite above that of the ſecond; which exceſs is equal to the difference between the mean ſynodical longitudes of the two ſatellites. The period of this inequality does not amount to 4 days. How comes it then, it will be aſked, to change into a period of 437.75 days, with reſpect to the eclipſes of the firſt ſatellite? Let us ſuppoſe, that the firſt and ſecond ſatellite ſet out together from their mean oppoſition to the ſun. During every revolution of the firſt ſatellite, in conſequence of its mean ſynodical motion, it will be in mean oppoſition. Suppoſe a fictitious ſtar, whoſe angular motion is owing to the exceſs of the mean ſynodical motion of the firſt ſatellite, over that of the ſecond, then twice the difference of the mean ſynodical motions of the two ſatellites will in the eclipſes of the firſt be equal to a multiple of the circumference together with the motion of the fictitious ſtar. Of courſe the ſine of this laſt motion will be proportional to the inequality of the firſt ſatellite in its eclipſes, and may repreſent that inequality. Its period is equal to the duration of the revolution of the fictitious ſtar, which according to the mean motion of the two ſatellites is 437.75 days. Thus it is determined with more preciſion than by direct obſervation.

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The irregularity of the ſecond ſatellite follows a law ſimilar to that of the firſt; but its ſign is always contrary. It accelerates, or retards the eclipſes 932″ in time when at its maximum. When compared with the poſition of the two ſatellites we perceive that it diſappears when they are in oppoſition to the ſun at the ſame time; that it retards the time of the eclipſes more and more, till the two ſatellites are diſtant from each other 90° at at the time when they take place; then the retardation diminiſhes and vaniſhes altogether, when the two ſatellites are 180° from each other at the time of the eclipſes. It then accelerates the eclipſes in the other half of the circumference preciſely as it had retarded them before. From theſe obſervations it has been concluded that there exiſts in the motion of the ſecond ſatellite an irregularity of 3647″ at its maximum proportional, (*but with a contrary ſign*) to the ſine of the exceſs of the mean longitude of the firſt ſatellite above that of the ſecond, which exceſs is equal to the difference of the mean ſynodical motions of the two ſatellites.

If the two ſatellites ſet out together from their mean oppoſition to the ſun; the ſecond ſatellite will be in mean oppoſition every time that it completes a ſynodical revolution. If we ſuppoſe as before, a ſtar whoſe angular motion is equal to the exceſs of the mean ſynodical movement of the firſt ſatellite, or twice that of the ſecond, then the difference of the two ſynodical movements of the two ſatellites will, at the eclipſes of the ſecond, equal a multiple of the circumference together with the motion of the fictitious ſtar. Of courſe the inequality of the ſecond during its eclipſe will be proportional to the ſine of the angular motion of that fictitious ſtar. Hence the reaſon that the period and law of that irregularity are the ſame as in the irregularity of the firſt ſatellite.

If the third ſatellite produces in the motion of the ſecond an inequality reſembling that which the ſecond ſeems to produce in the motion of the firſt, that is to ſay, proportional to the ſine of twice the difference of the mean longitudes of the ſecond and third ſatellite; that new inequality will coincide with that which is due to the firſt ſatellite. For in conſequence of the relation which the mean longitude of the three firſt ſatellites have to each other, the difference of the mean longitudes of the two firſt ſatellites is equal to the ſemicircumference

Real Motions of the Heavenly Bodies.

cumference together with twice the difference of the mean longitudes of the ſecond and third ſatellites, ſo that the ſine of the firſt difference is the ſame as the ſine of double the ſecond difference, but with a contrary ſign. The inequality produced by the third ſatellite in the motion of the ſecond, will therefore have the ſame ſign, and will follow the ſame law as the inequality obſerved in that motion. It is, therefore, very probable that this inequality is the reſult of two inequalities depending on the firſt and third ſatellite. If in the courſe of ages, the preceding relation between the mean longitudes of theſe three ſatellites ſhould ceaſe to exiſt, theſe two inequalities at preſent compounded, would ſeparate, and their reſpective values might be diſcovered.

The inequality relative to the third ſatellite in its eclipſes, compared with the reſpective poſitions of the ſecond and third, offers the ſame relations with the inequality of the ſecond compared with the reſpective ſituations of the two firſt. There exiſts then in the motion of the third ſatellite, an inequality which at its maximum amounts to 268″. If we ſuppoſe a ſtar whoſe angular motion is equal to the exceſs of the mean ſynodical motion of the ſecond ſatellite, above twice the mean ſynodical motion of the third, the inequality of the third ſatellite will in its eclipſes be proportional to the motion of this fictitious ſtar. But in conſequence of the relation which exiſts between the mean longitude of the three ſatellites, the ſine of this motion is the ſame (except its ſign), with that of the motion of the firſt fictitious ſtar which we formerly conſidered. Therefore the inequality of the third ſatellite in its eclipſes has the ſame period, and follows the ſame laws, with the inequalities of the two firſt ſatellites: ſuch are the laws of the principal irregularities of the three firſt ſatellites of Jupiter.

329 Satellites of Saturn.

Let us now conſider the ſatellites of Saturn, which are ſeven in number. The ſatellites of Saturn have not as yet proved ſo uſeful to aſtronomy or geography as thoſe of Jupiter; principally becauſe they cannot be ſeen unleſs very powerful teleſcopes be uſed. Five of thoſe ſatellites were diſcovered in the year 1685, by Caſſini and Huygens, who uſed teleſcopes conſiſting of two ſimple lenſes, but upwards of 100 feet in length; and thoſe were called 1ſt, 2d, 3d, &c. reckoning from the planet. Two others were diſcovered by Dr Herſchel in the years 1787 and 1788, and theſe are ſmaller and nearer to the planet, on which account they ought to have been called the firſt and ſecond, at the ſame time that the other five ought to have been called 3d, 4th, 5th, 6th, and 7th; but, imagining that this might create ſome confuſion in the reading of old aſtronomical books, the five old ſatellites have been ſuffered to retain their numerical names, and the two new ſatellites are now called the 6th and the 7th; ſo that the 7th is the neareſt to the planet, then comes the 6th, then the 1ſt; and this is followed by the 2d, 3d, 4th, and 5th.

The inclinations of the orbits of the 1ſt, 2d, 3d, and 4th ſatellites, to the ecliptic, are from 30° to 31°. That of the 5th is from 17° to 18°. Of all the ſatellites of the ſolar ſyſtem, none, except the 5th of Saturn, has been obſerved to have any ſpots, from the motion of which the rotation of the ſatellite round its own axis might be determined. Then the 5th ſatellite of Saturn, as Dr Herſchel has diſcovered, turns round its own axis; and it is remarkable, that, like our moon, it revolves round its axis exactly in the ſame time that it revolves round its primary.

The following table ſtates the particulars which have been aſcertained with reſpect to the ſatellites of Saturn.

The SATELLITES of SATURN.

Satellites.	Periods.				Diſt. in ſemi-dia. of Saturn.	Diſt. in miles.	App. diam. of orbits.	
	d.	h.	m.	s.			′	″
Seventh	0	22	40	46	$2\frac{5}{6}$	107,000	0	57
Sixth	1	8	53	9	$3\frac{5}{9}$	135,000	1	14
Firſt	1	21	18	27	$4\frac{3}{8}$	170,000	1	27
Second	2	17	41	22	$5\frac{1}{2}$	217,000	1	52
Third	4	12	25	12	8	303,000	2	36
Fourth	15	22	41	13	18	704,000	6	18
Fifth	79	7	48	0	54	2,050,000	17	4

The planet Herſchel, with its ſix ſatellites, have been entirely diſcovered by Dr Herſchel. The planet itſelf may be ſeen with almoſt any teleſcope; but its ſatellites cannot be perceived without the moſt powerful inſtruments, and the concurrence of all other favourable circumſtances. One of theſe ſatellites Dr Herſchel found to revolve round its primary in 8 d. 17 h. 1 m. 19 ſec.; the period of another he found to be 13 d. 11 h. 5 m. 1.5 ſec. The apparent diſtance of the former from the planet is 33″; that of the ſecond 44″$\frac{2}{3}$. Their orbits are nearly perpendicular to the plane of the ecliptic. 330 Satellites of Herſchel.

The other four ſatellites were diſcovered a conſiderable time after, and of courſe Dr Herſchel has had leſs time to make obſervations upon them. They are altogether very minute objects; ſo that the following particulars muſt be conſidered as being not accurate but probable. "Admitting the diſtance of the interior ſatellite to be 25″.5, its periodical revolution will be 5 d. 21 h. 25 m.

"If the intermediate ſatellite be placed at an equal diſtance between the two old ſatellites, or at 38″.57, its period will be 10 d. 23 h. 4 m. The neareſt exterior ſatellite is about double the diſtance of the fartheſt old one; its periodical time will therefore be about 38 d. 1 h. 49 m. The moſt diſtant ſatellite is full four times as far from the planet as the old ſecond ſatellite; it will therefore take at leaſt 107 d. 16 h. 40 m. to complete one revolution. All theſe ſatellites perform their revolutions in their orbits contrary to the order of the ſigns; that is, their real motion is retrograde."

Part IV. OF THE THEORY OF UNIVERSAL GRAVITATION.

Having in the last two parts of this treatise given an account of the apparent and real motions of the heavenly bodies, it only remains for us to compare these motions with the laws established by mathematicians, in order to ascertain the forces that animate the solar system, and to acquire notions of the general principle of gravitation on which they depend. To develope this part of the subject properly, three particulars claim our attention. We must in the first place lay down the laws of motion as established by mathematicians; in the second place, we must apply these laws to the heavenly bodies, which will furnish us with the theory of gravitation; and, in the third place, we must apply this theory to the planetary system, and demonstrate that the whole motions of the heavenly bodies are explicable by that theory, and merely cases of it. These particulars shall be the subject of the three following chapters.

Chap. I. *Of the Laws of Motion.*

The laws of motion, by which all matter is regulated, and to which it is subject notwithstanding the variety of phenomena which it continually exhibits, constitute the first principles of mechanical philosophy. They will claim a separate place hereafter in this work, under the title of dynamics; but some notions of them are requisite in order to understand the theory of gravitation. We shall satisfy ourselves in this place with the following short sketch.

331 Motion. A body appears to us to *move* when it changes its situation with respect to other bodies which we consider as at rest. Thus in a vessel sailing down a river, bodies are said to be in motion when they correspond successively to different parts of the vessel. But this motion is merely relative. The vessel itself is moving along the surface of the river, which turns round the axis of the earth, while the centre of the earth itself is carried round the sun, and the sun with all its attendant planets is moving through space. This renders it necessary to refer the motion of a body to the parts of *space*, which is considered as boundless, immoveable, and penetrable. A body then is said to be in motion when it corresponds successively to different parts of space.

332 Moving forces. Matter, as far as we know, is equally indifferent to motion or rest. When in motion it moves for ever unless stopt by some cause, and when at rest it remains so, unless put in motion by some cause. The cause which puts matter in motion is called a *force.* The *nature* of *moving forces* is altogether unknown, but we can measure their effects.

333 Composition of forces. Whenever a force acts upon matter it puts it in motion, if no other force prevent this effect; the straight line which the body describes, is called the *direction* of the force. Two forces may act upon matter at the same time. If their direction be the same, they increase the motion; if their direction be opposite they destroy each other; and the motion is nothing if the two forces be equal; it is merely the excess of the one force above the other if the motions be unequal. If the directions of the two forces make with each other any angle whatever, the resulting motion will be in a direction between the two. And it has been demonstrated, that if lines be taken to represent the direction and amount of the forces, if these lines be converted into a paralellogram by drawing parallels to them; the diagonal of that paralellogram will represent the direction and quantity of the resulting motion. This is called the composition of forces.

For two forces thus acting together, we may substitute their result, and *vice versa.* Hence we may decompose a force into two others, parallel to two axes situated in the same plane, and perpendicular to each other.

Thus finding that a body A, fig. 117. has moved from A to C, we may imagine either that the body has been impelled by a single force in the direction of A C, and proportionate to the length of A C, or that it has been impelled by two forces at once, viz. by one in the direction of A D, and proportionate to the length of A D; and by another force in the direction of A B or D C, and proportionate to A B or D C. Therefore, if two sides of any triangle (as A D and D C) represent both the quantities and the directions of two forces acting from a given point, then the third side (as A C) of the triangle will represent both the quantity and the direction of a third force, which acting from the same point, will be equivalent to the other two, and *vice versa.*

Thus also in fig. 118. finding that the body A has moved along the line A F from A to F in a certain time; we may imagine, 1st, that the body has been impelled by a single force in the direction and quantity represented by A F; or 2dly, that it has been impelled by two forces, viz. the one represented by A D, and the other represented by A E; or thirdly, that it has been impelled by three forces, viz. those represented by AD, A B, and A C; or lastly, that it has been impelled by any other number of forces in any directions; provided all these forces be equivalent to the single force which is represented by A F.

This supposition of a body having been impelled by two or more forces to perform a certain course; or, on the contrary, the supposition that a body has been impelled by a single force, when the body is actually known to have been impelled by several forces, which are, however, equivalent to that single force; has been called the composition and resolution of forces.

The knowledge of these principles gives mathematicians an easy method of obtaining the result of any number of forces whatever acting on a body. For every particular force may be resolved into three others, parallel to three axes given in position, and perpendicular to each other. It is obvious, that all the forces parallel to the same axis are equivalent to a single force, equal to the sum of all those which act in one direction, diminished by the sum of those which act 334 Resolution of forces.

act in the oppofite direction. Thus the body will be acted on by three forces perpendicular to each other: if the direction of thefe forces be reprefented by the fides of a parallelopiped, the refulting force will be reprefented by the diagonal of that parallelopiped.

The indifference of a material body to motion or reft, and its perfeverance in either ftate when put into it, is called the *vis inertiæ* of matter. This property is confidered as the firft law of motion. Hence, whenever the ftate of a body changes, we afcribe the change to the action of fome caufe: hence the motion of a body when not altered by the action of fome new force, muft be uniform and in a ftraight line.

335 Velocity.

In fuch uniform motions the fpace paffed over is proportional to the time: but the time employed to defcribe a given fpace will be longer or fhorter according to the greatnefs of the moving force. This difference in the time of traverfing the fame fpace gives us the notion of *velocity*, which in uniform motions is the ratio between the fpace and the time employed in traverfing it. As fpace and time are heterogeneous quantities, they cannot indeed be compared together; it is the ratio between the numbers reprefenting each that conftitutes velocity. A unity of time, a fecond for inftance, is chofen, and in like manner a unity of fpace, as a foot. Thus, if one body move over 20 feet in one fecond, and another only 10, then the velocity of the firft is double that of the fecond; for the ratio between 20 and 1 is twice as great as the ratio of 10 to 1. When the fpace, time, and velocity, are reprefented by numbers, we have the fpace equal to the velocity multiplied by the time, and the time equal to the fpace divided by the time.

The force by which a body is moved is proportional to the velocity, and therefore is meafured by the velocity. This has been difputed by fome philofophers, but has been fufficiently eftablifhed. We fhall confider it, therefore, as a matter of fact, referring the reader for a difcuffion of the fubject to the article DYNAMICS.

336 Accelerating forces.

When a body is put in motion by forces which not only act at firft, but which continue to act uniformly, it will defcribe a curve line, the nature of which depends upon the forces which occafion the motion. *Gravitation* is an inftance of a force which acts in this manner. Let us confider it a little. It appears to act in the fame manner in a body at reft and in motion. A body abandoned to its action acquires a very fmall velocity the firft inftant; the fecond inftant it acquires a new velocity equal to what it had the firft inftant; and thus its velocity increafes every inftant in proportion to the time. Suppofe a right-angled triangle, one of the fides of which reprefents the time, and the other the velocity. The fluction of the furface of the triangle being equal to the fluction of the time multiplied by that of the velocity, will reprefent the fluction of the fpace. Hence the whole triangle will reprefent the fpace defcribed in a given time. But the triangle increafing as the fquare of either of its fides, it is obvious, that in the accelerated motion produced by gravitation, the velocities increafe with the times, and the heights from which a body falls from reft increafe as the fquares of the times or of the velocities. Hence, if we denote by 1 the fpace through which a body falls the firft fecond, it will fall 4 in 2″, 9 in 3″, and fo on; fo that every fecond it will defcribe fpaces increafing as the odd numbers 1, 3, 5, 7, &c. This important point will perhaps be rendered more intelligible by the following diagram.

Let AB, fig. 119. reprefent the time during which a body is defcending, and let BC reprefent the velocity acquired at the end of that time. Complete the triangle ABC, and the parallelogram ABCD. Alfo fuppofe the time to be divided into innumerable particles, *ei*, *im*, *mp*, *po*, &c. and draw *ef*, *ik*, *mn*, &c. all parallel to the bafe BC. Then, fince the velocity of the defcending body has been gradually increafing from the commencement of the motion, and BC reprefents the ultimate velocity; therefore the parallel lines *ef*, *ik*, *mn*, &c. will reprefent the velocities at the ends of the refpective times A*e*, A*i*, A*m*, &c. Moreover, fince the velocity during an indefinitely fmall particle of time, may be confidered as uniform; therefore the right line *ef* will be as the velocity of the body in the indefinitely fmall particle of time *ei*; *ik* will be as the velocity in the particle of time *im*, and fo forth. Now the fpace paffed over in any time with any velocity is as the velocity multiplied by the time; viz. as the rectangle under that time and velocity; hence the fpace paffed over in the time *ei* with the velocity *ef*, will be as the rectangle *if*; the fpace paffed over in the time *im* with the velocity *ik*, will be as the rectangle *mk*; the fpace paffed over in the time *mp* with the velocity *mn*, will be as the rectangle *pn*, and fo on. Therefore the fpace paffed over in the fum of all thofe times, will be as the rectangle *pn*, and fo on. Therefore the fpace paffed over in the fum of all thofe times, will be as the fum of all thofe rectangles. But fince the particles of time are infinitely fmall, the fum of all the rectangles will be equal to the triangle ABC. Now fince the fpace paffed over by a moving body in the time AB with a uniform velocity BC, is as the rectangle ABCD, (viz. as the time multiplied by the velocity) and this rectangle is equal to twice the triangle ABC (Eucl. p. 31. B. I.) therefore the fpace paffed over in a given time by a body falling from reft, is equal to half the fpace paffed over in the fame time with an uniform velocity, equal to that which is acquired by the defcending body at the end of its fall.

Since the fpace run over by a falling body in the time reprefented by AB, fig. 120. with the velocity BC is as the triangle ABC, and the fpace run over in any other time AD, and velocity DE is reprefented by the triangle ADE; thofe fpaces muft be as the fquares of the times AB AD; for the fimilar triangles ABC, and ADE, are as the fquares of their homologous fides, viz. ABC is to ADE as the fquare of AB is to the fquare of AD, (Eucl. p. 29. B. VI.)

When a body is placed upon an inclined plane, the force of gravity which urges that body downwards, acts with a power fo much lefs, than if the body defcended freely and perpendicularly downwards, as the elevation of the plane is lefs than its length.

The fpace which is defcribed by a body defcending freely from reft towards the earth, is to the fpace which it will defcribe upon the furface of an inclined plane in the fame time as the length of the plane is to its elevation, or as radius is to the fine of the plane's inclination to the horizon.

If upon the elevation BC, fig. 121. of the plane BD, as as a diameter, the ſemicircle BEGC be deſcribed, the part BE of the inclined plane, which is cut off by the ſemicircle, is that part of the plane over which a body will deſcend, in the ſame time that another body will deſcend freely and perpendicularly along the diameter of the circle, viz. from B to C, which is the altitude of the plane, or ſine of its inclination to the horizon.

The time of a body's deſcending along the whole length of an inclined plane, is to the time of its deſcending freely and perpendicularly along the altitude of the plane, as the length of the plane is to its altitude; or as the whole force of gravity is to that part of it which acts upon the plane.

A body by deſcending from a certain height to the ſame horizontal line, will acquire the ſame velocity whether the deſcent be made perpendicularly, or obliquely, over an inclined plane, or over many ſucceſſive inclined planes, or laſtly over a curve ſurface.

From theſe propoſitions, which have been ſufficiently eſtabliſhed by mathematicians, it follows, that in the circle ABC (fig. 122.), a body will fall along the diameter from A to B, or along the chords CB, DB, in exactly the ſame line by the action of gravity.

When a body is projected in any line whatever not perpendicular to the earth's ſurface, it does not continue in that line, but continually deviates from it, deſcribing a curve, of which the primary line of direction is a tangent. The motion of the body relative to this line is uniform. But if vertical lines be drawn from this tangent to the curve, it will be perceived that its velocity is uniformly accelerated in the direction of theſe verticals. They are proportional to the ſquares of the correſponding parts of the tangent. This property ſhows us that the curve in which the body projected moves is a parabola.

337 Of the pendulum.

The oſcillations of the pendulum are regulated likewiſe by the ſame law of gravitation. The fundamental propoſitions reſpecting pendulums are the following:

If a pendulum be moved to any diſtance from its natural and perpendicular direction, and there be let go, it will deſcend towards the perpendicular, then it will aſcend on the oppoſite ſide nearly as far from the perpendicular, as the place whence it began to deſcend; after which it will again deſcend towards the perpendicular, and thus it will keep moving backwards and forwards for a conſiderable time; and it would continue to move in that manner for ever, were it not for the reſiſtance of the air, and the friction at the point of ſuſpenſion, which always prevent its aſcending to the ſame height as that from which it laſtly began to deſcend.

The velocity of a pendulum in its loweſt point is as the chord of the arch which it has deſcribed in its deſcent.

The very ſmall vibrations of the ſame pendulum are performed in times nearly equal; but the vibrations through longer and unequal arches are performed in times ſenſibly different.

As the diameter of a circle is to its circumference, ſo is the time of a heavy body's deſcent from reſt through half the length of a pendulum to the time of one of the ſmalleſt vibrations of that pendulum.

It is from theſe propoſitions, and the experiments made with pendulums, that the ſpace deſcribed by a body falling from reſt by the action of gravity has been aſcertained.

The late Mr John Whitehurſt, an ingenious member of the Royal Society, ſeems to have contrived and performed the leaſt exceptionable experiments relatively to this ſubject. The reſult of his experiments ſhews, that the length of the pendulum which vibrates ſeconds in London, at 113 feet above the level of the ſea, in the temperature of 60° of Fahrenheit's thermometer, and when the barometer is at 30 inches, is 39,1196 inches; whence it follows that the ſpace which is paſſed over by bodies deſcending perpendicularly, in the firſt ſecond of time, is 16,087 feet. This length of a ſecond pendulum is certainly not mathematically exact, yet it may be conſidered as ſuch for all common purpoſes; for it is not likely to differ from the truth by more than $\frac{1}{1000}$th part of an inch.

By theſe propoſitions, alſo, the variations of gravity in different parts of the earth's ſurface and on the tops of mountains has been aſcertained. Newton alſo has ſhown, by means of the pendulum, that gravity does not depend upon the ſurface nor figure of a body.

338 Of central forces.

The motion of bodies round a centre affords another well known inſtance of a conſtant force. As the motion of matter left to itſelf is uniform and rectilinear, it is obvious that a body moving in the circumference of a curve, muſt have a continual tendency to fly off at a tangent. This tendency is called a *centrifugal force*, while every force directed towards a centre is called a *central* or *centripetal force*. In circular motions the central force is equal, and directly contrary, to the centrifugal force. It bends conſtantly, to bring the body towards the centre, and in a very ſhort interval of time, its effect is meaſured by the verſed ſine of the ſmall arch deſcribed.

Let A (fig. 123.) be the centre of a force. Let a body in B be moving in the direction of the ſtraight line BC, in which line it would continue to move if undiſturbed; but being attracted by the centripetal force towards A, the body muſt neceſſarily depart from this line BC; and being drawn into the curve line BD, muſt paſs between the lines AB and BC. It is evident, therefore, that the body in B being gradually turned off from the ſtraight line BC, it will at firſt be convex towards that line, and concave towards A. And that the curve will always continue to have this concavity towards A, may thus appear: In the line BC, near to B, take any point, as E, from which the line EFG may be ſo drawn as to touch the curve line BD in ſome point, as F. Now, when the body is come to F, if the centripetal power were immediately to be ſuſpended, the body would no longer continue to move in a curve line, but, being left to itſelf, would forthwith reaſſume a ſtraight courſe, and that ſtraight courſe would be in the line FG; for that line is in the direction of the body's motion of the point F. But the centripetal force continuing its energy, the body will be gradually drawn from this line FG ſo as to keep in the line FD, and make that line, near the point F, to be concave towards the point A; and in this manner the body may be followed in its courſe throughout the line BD, and every part of that line be ſhown to be concave towards the point A.

Again, the point A (fig. 124.) being the centre of a centripetal force, let a body at B ſet out in the direction

Theory of Universal Gravitation.

rection of the straight line BC, perpendicular to the line AB. It will be easily conceived, that there is no other point in the line BC so near to A as the point B; that AB is the shortest of all the lines which can be drawn from A to any part of the line BC; all others, as AD or AE, being longer than AB. Hence it follows, that the body setting out from it, if it moved in the line BC, would recede more and more from the point A. Now, as the operation of a centripetal force is to draw a body towards the centre of that force, if such a force act upon a resting body, it must necessarily put that body so into motion as to cause it move towards the centre of the force: if the body were of itself moving towards that centre, it would accelerate that motion, and cause it to move faster down; but if the body were in such a motion that it would of itself recede from the centre, it is not necessary that the action of a centripetal power should make it immediately approach the centre from which it would otherwise have receded; the centripetal force is not without effect if it cause the body to recede more slowly from that centre than otherwise it would have done. Thus, the smallest centripetal power, if it act on the body, will force it out of the line BC, and cause it to pass in a bent line between BC and the point A, as has been already explained. When the body, for instance, has advanced to the line AD, the effect of the centripetal force discovers itself by having removed the body out of the line BC, and brought it to cross the line AD somewhere between A and D, suppose at F. Now, AD being longer than AB, AF may also be longer than AB. The centripetal power may indeed be so strong, that AF shall be shorter than AB; or it may be so evenly balanced with the progressive motion of the body that AF and AB shall be just equal; in which case the body would describe a circle about the centre A; this centre of the force being also the centre of the circle.

If now the body, instead of setting out in the line BC perpendicular to AB, had set out in another line BG more inclined towards the line AB, moving in the curve line BH; then, as the body, if it were to continue its motion in the line BG, would for some time approach the centre A, the centripetal force would cause it to make greater advances towards that centre: But if the body were to set out in the line BI, reclined the other way from the perpendicular BC, and were to be drawn by the centripetal force into the curve line BK; the body, notwithstanding any centripetal force, would for some time recede from the centre; since some part at least of the curve line BK lies between the line BI and the perpendicular BC.

Let us next suppose a centripetal power directed toward the point A (fig. 109.), to act on a body in B, which is moving in the direction of the straight line BC, the line BC reclining off from AB. If from A the straight lines AD, AE, AF, are drawn to the line CB, prolonged beyond B to G, it appears that AD is inclined to the line GC more obliquely than AB, AE more obliquely than AD, and AF than AE; or, to speak more correctly, the angle under ADG is less than that under ABG, that under AEG is less than ADG, and AFG less than AEG. Now suppose the body to move in the curve line BHIK, it is likewise evident that the line BHIK being concave towards A and convex towards BC, it is more and more turned off from that line; so that in the point H, the line AK will be more obliquely inclined to the curve line BHIK than the same line AHD is inclined to BC at the point D; at the point I the inclination of the line AI to the curve line will be more different from the inclination of the same line AIE to the line BC at the point IE; and in the points K and F the difference of inclination will be still greater; and in both, the inclination at the curve will be less oblique than at the straight line BC. But the straight line AB is less obliquely inclined to BG than AD is inclined towards DG: therefore, although the line AH be less obliquely inclined towards the curve HB than the same line AHD is inclined towards DG, yet it is possible, that the inclination at H may be more oblique than the inclination at B. The inclination at H may indeed be less oblique than the other, or they may be both the same. This depends upon the degree of strength wherewith the centripetal force exerts itself during the passage of the body from B to H: and in like manner the inclinations at I and K depend entirely on the degree of strength wherewith the centripetal force acts on the body in its passage from H to K: if the centripetal force be weak enough, the lines AH and AI drawn from the centre A to the body at H and at I, shall be more obliquely inclined to the curve than the line AB is inclined towards BG. The centripetal force may be of such a strength as to render all these inclinations equal; or if stronger, the inclination at I and K will be less oblique than at B; and Sir Isaac Newton has particularly shown, that if the centripetal power decreases after a certain manner without the increase of distance, a body may describe such a curve line, that all the lines drawn from the centre to the body shall be equally inclined to that curve line.

339 Revolution of a body round a centre explained.

We must further remark, that if the centripetal power, while the body increases its distance from the centre, retain sufficient strength to make the lines drawn from the centre to the body to become at length less oblique to the curve; then, if this diminution of the obliquity continue, till at last the line drawn from the centre to the body shall cease to be obliquely inclined to the curve, and become perpendicular thereto; from this instant the body shall no longer recede from the centre, but in its following motion shall again descend, and describe a curve in all respects like that which it has described already, provided the centripetal power, everywhere at the same distance from the body, acts with the same strength. This return of the body may be proved by the following proposition: That if the body in any place, suppose at I, were to be stopped, and thrown directly backward with the velocity wherewith it was moving forward in that point I, then the body, by the action of the centripetal force upon it, would move back again over the path IHB, in which it had before advanced forward, and would arrive again at the point B in the same space of time as was taken up in its passage from B to I; the velocity of the body at its return from the point B being the same as that wherewith it first set out from that point.

The truth of this proposition may be illustrated in the following manner. Suppose, in fig. 110. that a

body

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body were carried after the following manner through the bent figure ABCDEF, composed of the straight lines AB, BC, CD, DE, EF: let the body then first be supposed to receive an impulse to some point within the concavity of the figure, as G. Now, as this body, when once moving in the straight line AB, will continue to move on in this line as long as it shall be left to itself; but being disturbed at the point B by the impulse given it, it will be turned out of this line AB into some other straight line, wherein it will afterwards continue to move as long as it shall be left to itself; therefore, let this impulse have strength sufficient to turn the body into the line BC; then let the body move on undisturbed from B to C: but at C let it receive another impulse pointed also towards G, and of sufficient strength to turn the body into the line CD; at D let a third impulse turn it into the line DE; and at E let another turn it into EF. Now, if the body, while moving on in the line EF, be stopped and turned back again with the same velocity with which it was moving forward, then by the repetition of the former impulse at E, the body will be turned into the line E D, and move in it from E to D with the same velocity as that wherewith it was moving forward in this line: then by a repetition of the impulse at D, when the body shall have returned to that point, it will be turned into the line DC; and by the repetition of the former impulses at C and at B, the body will be brought back again into the line BA, with the velocity wherewith it first moved in that line.

To illustrate this still farther, let DE and FE be continued beyond E. In DE thus continued, take at pleasure the length EH, and let HI be so drawn as to be equidistant from the line GE; then, from the second law of motion, it follows, that after the impulse on the body on E, it will move through the space EI in the same time it would have employed in moving from E to H with the velocity it had in the line DE. In FE prolonged, take EK equal to EI and draw KL equidistant from GE. Then, because the body is thrown back in the line FE, with the same velocity with which it went forward in that line, if, when the body was turned to E, it were permitted to go straight on, it would pass through EK in the same time as it took up in passing through EI, when it went forward in the line EF. But if, at the body's return to the point E, such an impulse directed toward the point D were to be given it as was sufficient to turn it into the line DE, it is plain that this impulse must be equal to that which originally turned the body out of the line DE into EF; and that the velocity with which the body will return into the line ED is the same as that wherewith it moved before through this line from D to E. Because EK is equal to EI, and KL and HI being each equidistant from GE, are by consequence equidistant from each other; it follows, that the two triangular figures IEH and KEL, are altogether like and equal to each other. EK therefore being equal to EI, and EL equal to KH, and KL equal to HL, it is plain, that the body, after its return to E, being turned out of the line FE into ED by an impulse acting upon it in E after the manner above mentioned, it will receive such a velocity by this impulse as will carry it through EL in the same time it would have taken to go through EK, if it had passed through it undisturbed. It has already been observed, that the time in which the body would pass over EK, with the velocity wherewith it returns, is equal to the time it took up in going forward from E to I; that is, to the time in which it would have gone through EH with the velocity wherewith it moved from D to E; therefore the time in which the body will pass from E to L, after its return into the line ED, is the same as would have been taken up by the body in passing through the line EH with the velocity wherewith it first moved in the line DE. Since, therefore, EL and EH are equal, the body returns into the line DE with the velocity which it had before in that line.—Again, we may affirm, that the second impulse in E is equal to the first; for, as the impulse in E, whereby the body was turned out of the line DE into the line EF, is of such strength, that if the body had been at rest when this impulse had acted upon it, it would have communicated as much motion to it, as would have been sufficient to carry it through a length equal to HI, in the time wherein the body would have passed from E to H, or in the time wherein it passed from E to I. In the same manner, on the return of the body, the impulse in E, whereby it is turned out of the line FE into ED, is of such strength, that if it had acted on the body at rest, it would have caused it move through a length equal to KL in the same time as the body would employ in passing through EK with the velocity wherewith it returns in the line FE: therefore the second impulse, had it acted on the body at rest, would have caused it to move through a length equal to KL, in the same space of time as would have been taken up by the body in passing through a length equal to HI were the first impulse to act on the body while at rest; that is, the effects of the first and second impulse on the body when at rest would be the same; for KL and HI are equal: consequently the second impulse is equal to the first. Thus, if the body be returned through FE with the velocity wherewith it moved forward, it has been shown how, by the repetition of the impulse which acted on it in E, the body will return again into the line DE with the velocity which it had before in that line. By the same method of reasoning it may be proved, that when the body is returned back to D, the impulse which before acted on that point will throw the body into the line DC with the velocity which it first had in that line; and the other impulses being successively repeated, the body will at length be brought back again into the line BA with the velocity wherewith it set out in that line.—Thus these impulses, by acting over again in an inverted order all their operations on the body, bring it back again through the path in which it had proceeded forward; and this obtains equally whatever be the number of straight lines whereof this curve figure is composed. Now, by a method of reasoning of which Sir Isaac Newton made much use, and which he introduced into geometry, thereby greatly enriching that science, we might make a transition from this figure, composed of a number of straight lines, to a figure of one continued curvature, and from a number of separate impulses repeated at distinct intervals to a continued centripetal force, and show, that because what has been here advanced holds universally true whatever be the number

ber of ftraight lines whereof the curve figure ACF is compofed, and however frequently the impulfes at the angles of this figure are repeated; therefore the fame will ftill remain true although this figure fhould be converted into one of a continued curvature; and thefe diftinct impulfes fhould be changed into a continual centripetal force.

This being allowed, fuppofe the body in K to have the line AK no longer obliquely inclined to its motion. In this cafe, if the body be turned back in the manner we have been confidering, it muft be directed back perpendicularly to AK: but if it had proceeded forward, it would likewife have moved in a direction perpendicular to AK: confequently, whether it move from this point K backward or forward, it muft defcribe the fame kind of courfe. Therefore, fince by being turned back it will go over again the line KIHB, if it be permitted to go forward, the line KL, which it fhall defcribe, will be altogether fimilar to the line KHB.

In like manner we may determine the nature of the motion, if the line wherein the body fets out be inclined, as in fig. 127. down toward the line BA drawn between the body and the centre. If the centripetal power fo much increafes in ftrength as the body approaches, that it can bend the path in which the body moves to that degree as to caufe all the lines, AH, AI, AK, to remain no lefs oblique to the motion of the body than AB is oblique to BC, the body fhall continually more and more approach the centre. But if the centripetal power increafes in fo much lefs a degree as to permit the line drawn from the centre to the body, as it accompanies the body in its motion, at length to become more and more erect to the curve wherein the body moves, and in the end, fuppofe at K, to become perpendicular to it; from that time the body fhall rife again. This is evident from what has been faid above; becaufe, for the very fame reafon, here alfo, the body will procced from the point K to defcribe a line altogether fimilar to that in which it has moved from B to K. Thus it happens as in the pendulum, which, all the time it approaches a perpendicular pofition towards the horizon, defcends more and more; but as foon as it is come into that fituation, it immediately rifes again by the fame degrees as it defcended before: fo here the body more and more approaches the centre all the time it is moving from B to K; but thenceforward it rifes from the centre again by the fame degrees as it approached before.

If, as in fig. 127. the line BC be perpendicular to AB; then, as has already been obferved, the centripetal power may be fo balanced with the progreffive motion of the body, that it may keep moving round the centre A conftantly at the fame diftance; as the body does when whirled about any point to which it is tied by a ftring. If the centripetal power be too weak to produce this effect, the motion of the body will prefently become oblique to the line drawn from itfelf to the centre; but if it be ftronger, the body muft conftantly keep moving in a curve to which a line drawn from it to the body is perpendicular.

If the centripetal power change with the change of diftance, in fuch a manner that the body, after its motion has become oblique to the line drawn from itfelf to the centre, fhall again become perpendicular thereto; then the body fhall, in its fubfequent motion, return again to the diftance of AB, and from that diftance take a courfe fimilar to the former: and thus, if the body move in a fpace void of all refiftance, which has been all along fuppofed, it will continue in a perpetual motion about the centre, defcending and afcending from it alternately. If the body, fetting out from B (fig. 126.) in the line BC perpendicular to AB, defcribe the line BDE, which in D fhall be oblique to the line AD, but in E fhall again become erect to AE, drawn from the body in E to the centre A; then from this point E the body fhall defcribe the line EFG entirely fimilar to BDE, and at G fhall be at the fame diftance as it was at B; and the line AG fhall be erect to the body's motion. Therefore the body fhall proceed to defcribe from G the line GHI altogether fimilar to the line GFE, and at I it will have the fame diftance from the centre as it had at E; and alfo have the line AI erect to its motion: fo that its fubfequent motion muft be in the line IKL fimilar to IKG, and the diftance AL equal to AG. Thus the body will go on in a perpetual round without ceafing, alternately enlarging and contracting its diftance from the centre.

If it fo happen that the point E fall upon the line BA, continued beyond A; then the point G will fall upon B, I on E, and L alfo on B; fo that the body will in this cafe defcribe a fimple curve line round the centre A, like the line BDEF in fig. 126. in which it will revolve from P to E, and from E to B, without end. If AE in fig. 126. fhould happen to be perpendicular to AB, in this cafe alfo a fimple line will be defcribed; for the point G will fall on the line BA prolonged beyond A; the point I on the line AE prolonged beyond A; and the point L on B; fo that the body will defcribe a line like the curve line BEGI in fig. 128. in which the oppofite points B and G are equally diftant from A; and the oppofite points E and L are alfo equally diftant from the fame point A. In other cafes the body will have a courfe of a more complicated nature.

Thus it muft be apparent how a body, while it is conftantly attracted towards the centre, may notwithftanding by its progreffive motion keep itfelf from falling down to the centre, defcribing about it an endlefs circuit, fometimes approaching and fometimes receding from it. Hitherto, however, we have fuppofed, that the centripetal power is everywhere of equal ftrength at the fame diftance from the centre: and this is indeed the cafe with that power which keeps the planets in their orbits; but a body may be kept on in a perpetual circuit round a centre, although the centripetal power be kept moving in any curve line whatever, that fhall have its concavity turned everywhere towards the centre of the force. To illuftrate this, we fhall in the firft place propofe the cafe of a body moving the incurvated figure ABCDE (fig. 129.), which is compofed of the ftraight lines, AB, BC, CD, DE, and AE; the motion being carried on in the following manner. Let the body firft move in the line AB with any uniform velocity. When it is arrived at the point B, let it receive an impulfe directed towards any point F taken within the figure; and let the impulfe be of fuch a ftrength as to turn the body out of the line AB into the line BC; The body after this impulfe, while

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while left to itself, will continue moving in the line BC. At C let the body receive another impulse directed towards the same point F, of such a strength as to turn it from the line CB into CD. At D, let the body, by another impulse, directed likewise towards the point F, be turned out of the line CD into DE. At E, let another impulse, directed likewise towards the point F, turn the body from the line DE into EA: and thus the body will, by means of these impulses, be carried through the whole figure ABCDE.

Again, when the body is come to the point A, if it there receive another impulse directed like the rest to the point F, and of such a degree of strength as to turn it into the line AB, wherein it first moved; the body will then return into this line with the same velocity it had originally. To understand this, let AB be prolonged beyond B at pleasure, suppose to G; and from G let GH be drawn; which, if produced, should always continue equidistant from BF, i. e. let GH be drawn parallel to BF, in the time, then, in which the body would have moved from B to G, had it not received a new impulse in B; by the means of that impulse it will have acquired a velocity which will carry it from B to H. After the same manner, if CI be taken equal to BH, and IK be drawn parallel to CF, the body will have moved from C to K, with the velocity which it has in the line CD, in the same time it would have employed in moving from C to I with the velocity it had in the line BC. Therefore, since CI and BH are equal, the body will move through CK in the same time as it would have taken up in moving from B to G with the velocity wherewith it moved through the line AB. Again, DL being taken equal to CK, and LM drawn parallel to DF, the body will, for the same reason as before, move through DM with the velocity which it has in the line DE, in the same time it would employ in moving through BG with its original velocity. Lastly, if EN be taken equal to DM, and NO be drawn parallel to EF; likewise, if AP be taken equal to EO, and PQ be drawn parallel to AF; then the body, with the velocity wherewith it runs into the line AB, will pass through AQ in the time it would have employed in passing through BG with its original velocity. Now as all this follows directly from what has been delivered concerning oblique impulses impressed upon bodies in motion; so we must here observe farther, that it can be proved by geometry, that AQ will always be equal to BG; which being granted, it follows, that the body has returned into the line AB with the same velocity which it had when it first moved in that line; for the velocity with which it returns into the line AB will carry it over the line AQ in the same time as would have been taken up in its passing over an equal line BG with the original velocity.

340 A body may be moved in any curvilinear direction by means of centripetal force.

The conclusion naturally deduced from the above reasoning is, that by means of a centripetal and projectile force, a body may be carried round any fixed point as a curve figure which shall be concave towards it, as that marked ABC, fig. 130. and when it is returned to that point from whence it set out, it shall recover again the velocity with which it departed from that point. It is not indeed always necessary that it should return again into its first course, for the curve line may have some such figure as ABCDBE in fig. 131. In this curve line, if the body set out from B in the direction BF, and moved through the line BCD till it returned to B; here the body would not enter again into the line BCD, because the two parts BD and BC of the curve line make an angle at the point B: so that the centripetal power, which at the point B would turn the body from the line BF into the curve, will not be able to turn it into the line BC from the direction in which it returns to the point B. A forcible impulse must be given the body in the point B to produce that effect. If, at the point B, whence the body sets out, the curve line return into itself, as in fig. 130. then the body, upon its arrival again at B, may return into its former course, and thus make an endless circuit about the centre.

341 Calculation of the force requisite to carry a body in any curve line.

The force requisite to carry a body in any curve line proposed, is to be deduced from the curvature which the figure has in any part of it. Sir Isaac Newton has laid down the following proposition as a foundation for discovering this, viz. that if a line be drawn from some fixed point to the body, and remaining by one extreme united to that point, it be carried round along with the body; then if the power whereby the body is kept in its course be always pointed to this fixed point as a centre, this line will move over equal spaces in equal portions of time. Suppose a body were moving through the curve line ABCD (fig. 132.), and passed over the arches AB, BC, CD in equal portions of time; then if a point, as E, can be found, from whence the line EA being drawn to the body in accompanying it in its motion, it shall make the spaces EAB, EBC, and ECD, over which it passes, equal where the times are equal; then is the body kept in this line by a power always pointed to E as a centre. To prove this, suppose a body set out from the point A, fig. 133. to move in the straight line AB; and after it had moved for some time in that line, it were to receive an impulse directed to some point, as C. Let it receive that impulse at D, and thereby be turned into the line DE; and let the body after this impulse, take the same time in passing from D to E that is employed in passing from A to D. Then the straight lines CA, CD, and CE being drawn, the triangular spaces CAD and CDE are proved to be equal in the following manner. Let EF be drawn parallel to CD. Then it follows, from the second law of motion, that since the body was moving in the line AB when it received the impulse in the direction DC, it will have moved after that impulse through the line DE in the same time as it would have moved through DF, provided it had received no disturbance in D. But the time of the body's moving from D to E is supposed to be equal to the time of its moving through AD; therefore the time which the body would have employed in moving through DF, had it not been disturbed in D, is equal to the time wherein it moved through AD: consequently DF is equal in length to AD; for if the body had gone on to move through the line AB without interruption, it would have moved through all the parts of it with the same velocity, and have passed over equal parts of that line in equal portions of time. Now CF being drawn, since AD and DF are equal, the triangular space CDF is equal to the triangular space CAD. Further, the line EF being parallel to CD, it follows from the 37th proposition of Euclid's first book, that the triangle

angle CED is equal to the triangle CFD: therefore the triangle CED is equal to the triangle CAD.

In like manner, if the body receive at E another impulſe directed toward the point C, and be turned by that impulſe into the line EG; if it move afterwards from E to G, in the ſame ſpace of time as was taken up by its motion from D to E, or from A to D; then CG being drawn, the triangle CEG is equal to CDE. A third impulſe at G, directed as the two former to C, whereby the body ſhall be turned into the line GH, will have alſo the like effect with the reſt. If the body move over GH in the ſame time as it took up in moving over EG, the triangle CGH will be equal to the triangle CEG. Laſtly, if the body at H be turned by a freſh impulſe directed towards C into the line HI, and at I by another impulſe directed alſo to C be turned into the line IK; and if the body move over each of the lines HI and IK in the ſame time as it employed in moving over each of the preceding lines AD, DE, EG, and GH: then each of the triangles CHI and CIK will be equal to each of the preceding. Likewiſe, as the time in which the body moves over ADE is equal to the time of its moving over EGH, and to the time of its moving over HIK; the ſpace CADE will be equal to the ſpace CEGH and to the ſpace CHIK. In the ſame manner, as the time in which the body moved over ADEG is equal to the time of its moving over GHIK, ſo the ſpace CADEG will be equal to the ſpace CGHIK. From this principle Sir Iſaac Newton demonſtrates the above-mentioned propoſition, by making the tranſition from this incurvated figure compoſed of ſtraight lines, to a figure of continued curvation; and by ſhowing, that ſince equal ſpaces are deſcribed in equal times in this preſent figure compoſed of ſtraight lines, the ſame relation between the ſpaces deſcribed, and the times of their deſcription, will alſo have place in a figure of one continued curvature. He alſo deduces from this propoſition the reverſe of it; and proves, that whenever equal ſpaces are continually deſcribed, the body is acted upon by a centripetal force directed to the centre at which the ſpaces terminate.

342 Compariſion of the centrifugal force with gravitation.

As the effect of a central force in a very ſmall interval of time is meaſured by the verſed ſine of the ſmall arch deſcribed, we may eaſily compare the centrifugal force produced by the rotation of the earth with gravitation. At the equator, a body in conſequence of the rotation of the earth deſcribes an arch of 15″ of the circumference of the earth, in 1″ of time. The radius of the equator is about 19634778 French feet; the verſed ſine of which is 0.0389704 feet. At the equator a body falls 11.23585 French feet in a ſecond. The centrifugal force is to gravity as 0.0389704 to 1123585, or nearly as 1 to 288.3. The centrifugal force diminiſhes gravity, and bodies only fall in conſequence of the exceſs of the laſt above the firſt. If the whole force whoſe effect would be evident, were there no rotation, be called *gravity*; then at the equator the centrifugal force is about $\frac{1}{289}$ of gravity. If the earth revolved 17 times faſter than it does, the arch deſcribed in a ſecond would be 17 times greater, and its verſed ſine 289 times longer; the centrifugal force would then be equal to gravity, and at the equator, bodies would ceaſe to have any weight.

In general the expreſſion of a uniformly accelerating force, acting conſtantly towards the ſame point, is equal to twice the ſpace which it cauſes the body to deſcribe, divided by the ſquare of the time. Every accelerating force may be ſuppoſed conſtant for a very ſmall interval of time, and acting in the ſame direction. The ſpace deſcribed by a body moving in a circle in conſequence of the central force, is the verſed ſine of the ſmall arch deſcribed; and this verſed ſine is very nearly equal to the ſquare of the arch divided by radius. The expreſſion of the accelerating force is then the ſquare of the arch deſcribed, divided by the ſquare of the time, and by radius. The arch divided by the time gives the velocity. Hence the centripetal and centrifugal forces are equal to the ſquare of the velocity divided by radius.

We have ſeen that gravity is equal to the ſquare of the acquired velocity divided by twice the ſpace gone through. Of courſe the centrifugal force is equal to gravity, if the velocity of the revolving body be that which it would acquire by falling from a height equal to half the radius of the circumference deſcribed. The velocities of different revolving bodies are as the circumferences which they deſcribe divided by the time of their revolution. Theſe circumferences are as their radii. The ſquares of the velocity of courſe are as the ſquares of the radii divided by the ſquares of the times. Hence centrifugal forces are to each other as the radii of the circumferences deſcribed divided by the ſquares of the times of the revolutions. Hence in different parallels of latitude, the centrifugal forces produced by the rotation of the earth are proportional to the radii of theſe parallels.

Theſe remarks will give the reader an idea of the laws of motion. For a more particular inveſtigation he muſt have recourſe to thoſe articles that treat particularly of Dynamics.

Chap. II. *Of Univerſal Gravitation.*

The principles of dynamics being underſtood, let us make uſe of them to examine the motions of the heavenly bodies, in order to detect the general laws which produce and regulate theſe motions.

We have ſeen that the planets and comets move in ellipſes round the ſun, and that the areas deſcribed by their radii vectors are proportional to the time. The principles of dynamics laid down in the laſt chapter, inform us that this could not happen unleſs each of theſe bodies were conſtantly acted on by a force turning them from the ſtraight line in the direction of the centre of theſe radii vectors. Hence it follows, that the planets are conſtantly acted upon by a force which urges them towards the ſun as a centre. 343 Planets revolve round the ſun,

Let us ſuppoſe that the planets revolve round the ſun in circles, which is not very far from the truth. 344 in conſequence of a force reſiding in the ſun.
In that caſe, the ſquares of their velocities are proportional to the ſquares of the radii of their orbits, divided by the ſquares of the times of their revolution. But by the laws of Kepler, the ſquares of the times are as the cubes of the radii of the orbits of the planet, or of the diſtance. Therefore, the ſquares of the velocity are reciprocally as theſe radii. Perhaps this reaſoning will be better underſtood by employing ſymbols. Let $t =$ the

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the time, $v =$ the velocity, and $r =$ the radius, we have $v^2 \doteq \frac{r^2}{t^2}$. But $t^2 \doteq r^3$, therefore, substituting r^3 in the first formula, we have $v^2 \doteq \frac{r^2}{r^3}$, but $\frac{r^2}{r^3} = \frac{1}{r}$, therefore we have $v^2 \doteq \frac{1}{r}$, or v^2 always reciprocally proportional to r. We have seen formerly that the central forces of different forces revolving in a circle, are as the squares of the velocity divided by the radii of their orbits. Therefore, the tendency of the planets to the sun, then, are reciprocally as the squares of the radii of their orbits, or their distance from the sun. This will be better understood if we express it by symbols. We have $v^2 \doteq \frac{1}{r}$. Let c denote the central force, $c \doteq \frac{v^2}{r}$; for v^2 substitute its equivalent $\frac{1}{r}$, and we have $c \doteq \frac{1}{r^2}$.

It is true that the orbits of the planets are not exactly circular; but as the law of the squares of the times, proportional to the cubes of the distances, is independent of the eccentricity of the planetary orbits, it is natural to suppose, that it would exist, even though the eccentricity were destroyed. The law, therefore, that the tendency to the sun is inversely as the square of the distance, is clearly indicated by this ratio.

345 This force inversely as the square of the distance.

Analogy leads us to suppose, that this law, which extends from one planet to another, holds also with respect to the same planet in all its different distances from the sun. That this is actually the case, follows with certainty from the elliptical orbits of the planets. When the planet is in its perihelion, its velocity is a maximum, and its tendency to separate from the sun in consequence of this velocity overcoming the tendency towards the sun, the radius vector increases in length, and forms obtuse angles with the direction of the planet. Hence it opposes, and of course, tends to diminish the velocity, till the planet reaches its aphelion. Then the radius vector becomes perpendicular to the curve, the velocity is at its minimum; and the tendency to separate from the sun being less than the tendency towards the sun, the planet approaches towards it, describing the second part of its elliptical orbit. In that part, the tendency to the sun increases the velocity of the planet, as in the former part it had diminished it: the planet accordingly comes to its perihelion with a maximum of velocity. Now the curvature of the ellipse being the same at the perihelion and aphelion, the radii of the equicurve circles will be the same, and, of course, the centrifugal forces in these two points will be to each other as the squares of the velocity. The sectors described in the same times being equal, the velocities at the aphelion and perihelion are reciprocally as the corresponding distances of the planet from the sun. Of course, the squares of the velocities are reciprocally as the squares of these distances, or at the perihelion and aphelion the centrifugal forces are equal to the tendency of the planet towards the sun. Therefore this tendency is inversely as the square of the distance of the planet from the sun.

346 Tendency the same in all the planets,

We see then, in general, that all the planets tend towards the sun, with a force inversely as the square of their distance. Newton demonstrated, that this force would cause them, if projected with a given velocity, to describe ellipses round the sun as a centre. He demonstrated farther, that this tendency is the same in all the planets, varying only according to their distances. Hence it follows, that if they were all at rest, and placed at the same distance from the sun, they would all, in consequence of this tendency, *fall* into the sun at the same instant; the same result must be applied also to the comets, for in them also the squares of the times are undoubtedly proportional to the cubes of their distance from the sun.

The satellites tend equally to the sun with the planets around which they revolve. Were not the moon under the influence of this tendency, instead of describing a circle round the earth, it would soon abandon it altogether. Unless the satellites of Jupiter and the moon tended towards the sun, irregularities would be perceptible in their orbits, which they do not exhibit. The planets, comets, and satellites, then, all tend to the sun in consequence of the action of the same force. While the satellites move round their planet, the entire system of planet and satellites is carried round the sun, and retained in their orbits by the same force. Of course, the motion of the satellites round the planet, is merely the same as if the planet were altogether at rest, and not acted upon by any foreign body. 347 and satellites.

348 Hence the sun's centre attracts all bodies.

Thus we have been led, without assuming any hypothesis, by the necessary consequence of the laws of the celestial movements, to consider the centre of the sun as the focus of a *force*, which extends itself indefinitely through space, diminishing inversely as the squares of the distance, and which *attracts* all bodies within the sphere of its activity. Each of Kepler's laws points out a property of this attractive force. The law of the areas proportional to the times, informs us, that the force is directed towards the sun; the elliptical figure of the planets proves to us, that its intensity diminishes as the square of the distance augments; and the law of the squares of the times proportional to the cubes of the distance, informs us, that the tendency, or *gravitation* of all the planets to the sun is the same, provided the distances were the same. We may call this force *solar attraction*, supposing for the sake of a distinct conception, that it is a *force* residing in the sun.

349 Satellites tend to their primaries.

The tendency or gravitation of the satellites towards their planets, is a necessary consequence of the areas described by their radii vectors being proportional to the times; that this gravitation is inversely as the square of their distance, is indicated by the ellipticity of their orbits. This ellipticity, indeed, being scarcely apparent in most of the satellites of Jupiter, Saturn, and Herschel, would leave some uncertainty, did not the third law, namely, the squares of the times being inversely as the cubes of their distance, demonstrate, that from one satellite to another, the tendency to the planet is inversely as the square of the distance.

350 Moon's tendency the same with gravitation.

This proof, indeed, is wanting with respect to our moon; but the defect may be supplied by the following considerations. *Gravity*, or the weight by which a body tends towards the earth, extends itself to the top of the highest mountains, aud the very trifling diminution which it experiences at that height, cannot permit us to doubt, that it would still be sensible at a considerably

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conſiderably greater diſtance from the earth's centre. Is it not natural to extend it as far as the moon, and to ſuppoſe that the force which retains that ſatellite in its orbit, is its *gravitation* towards the earth, juſt as it is the ſolar attraction which retains the planets in their orbits? The forces at leaſt ſeem to be of the ſame nature; they both act upon every particle of bodies, and cauſe them to move at the ſame rate; for the ſolar attraction acts equally upon all bodies placed at the ſame diſtance from the ſun, juſt as gravitation cauſes all bodies to fall from the ſame height with the ſame velocity. A body projected horizontally, falls upon the earth at ſome diſtance after deſcribing a curve ſenſibly parabolic. It would fall at a greater diſtance, if the force of projection were more conſiderable; and, if projected with a certain velocity, it would not fall back at all, but revolve round the earth like a ſatellite. To make it move in the orbit of the moon, it would be neceſſary only to give it the ſame height and the ſame projecting force. But what demonſtrates the identity of gravitation and of the force which retains the moon in its orbit is, that if we ſuppoſe gravity to diminiſh inverſely as the ſquare of the diſtance from the centre of the earth, at the diſtance of the moon it will be preciſely equal to the moon's tendency to the earth.

Let A in fig. 134. repreſent the earth, B the moon, BCD the moon's orbit; which differs little from a circle of which A is the centre. If the moon in B were left to itſelf to move with the velocity it has in the point B, it would leave the orbit, and proceed ſtraight forward in the line BE which touches the orbit in B. Suppoſe the moon would upon this condition move from B to E in the ſpace of one minute of time: By the action of the earth upon the moon, whereby it is

351 Her motion particularly explained.

retained in its orbit, the moon will really be found at the end of this minute in the point F, from whence a ſtraight line drawn to A ſhall make the ſpace BFA in the circle equal to the triangular ſpace BEA; ſo that the moon in the time wherein it would have moved from B to E, if left to itſelf, has been impelled towards the earth from E to F. And when the time of the moon's paſſing from B to F is ſmall, as here it is only one minute, the diſtance between E and F ſcarce differs from the ſpace through which the moon would deſcend in the ſame time if it were to fall directly down from B toward A without any other motion. AB, the diſtance of the moon from the earth, is about 60 of the ſemidiameters of the latter; and the moon completes her revolution round the earth in about 27 days 7 hours and 43 minutes: therefore the ſpace EF will here be found by computation to be about $16\frac{1}{8}$ feet. Conſequently, if the power by which the moon is retained in its orbit be near the ſurface of the earth greater than at the diſtance of the moon in the duplicate proportion of that diſtance, the number of feet a

352 Calculation of the velocity of falling bodies.

body would deſcend near the ſurface of the earth, by the action of this power upon it, in one minute, would be equal to the number $16\frac{1}{8}$ multiplied twice into the number 60; that is, to 58050. But how faſt bodies fall near the ſurface of the earth may be known by the pendulum; and by the exacteſt experiments, they are found to deſcend the ſpace of $16\frac{1}{8}$ feet in one ſecond; and the ſpaces deſcribed by falling bodies being in the duplicate proportion of the times of their fall, the number of feet a body would deſcribe in its fall near the ſurface of the earth in one minute of time will be equal to $16\frac{1}{8}$ twice multiplied by 60; the ſame as would be cauſed by the power which acts upon the moon.

353 Earth and moon move about their common centre of gravity.

In this computation the earth is ſuppoſed to be at reſt: but it would have been more exact to have ſuppoſed it to move, as well as the moon, about their common centre of gravity; as will be eaſily underſtood from what has been already ſaid concerning the motion of the ſun and primary planets about their common centre of gravity. The action of the ſun upon the moon is alſo here neglected; and Sir Iſaac Newton ſhows, if you take in both theſe conſiderations, the preſent computation will beſt agree to a ſomewhat greater diſtance of the moon and earth, viz. to $60\frac{1}{2}$ ſemidiameters of the latter, which diſtance is more conformable to aſtronomical obſervations: and theſe computations afford an additional proof that the action of the earth obſerves the ſame proportion to the diſtance which is here contended for.

We ſee then that the force which retains the moon in its orbit is *gravitation*, or that force which cauſes heavy bodies to fall to the ground. This compariſon between gravity and the lunar tendency to the earth ſhows us, that, in our calculations, we ought to meaſure diſtance from the centre of gravity of the ſun and of the planets; for this is obviouſly the caſe with the earth, and its tendency to the ſun is preciſely the ſame with that of the other planets.

354 Planets react upon the ſun.

The ſun and the planets which have ſatellites, poſſeſſing, as we have ſeen, an attractive force inverſely as the ſquare of the diſtance, one is tempted to give the ſame property to the other planets alſo. The ſphericity common to all theſe bodies, indicates clearly, that their particles are retained round their centre of gravity, by a force which at equal diſtances attracts them equally to that centre. But this important point is not left to analogical reaſoning. We have ſeen, that if the planets and comets were placed at equal diſtances from the ſun, their gravitation towards it would be proportional to their maſſes. But it may be conſidered as a general matter of fact, to which there is no exception, that action and reaction are equal and contrary. Of courſe all theſe bodies react upon the ſun, and *attract* it in proportion to their maſs, and conſequently poſſeſs an attractive force proportional to their maſs, and inverſely as the ſquare of their diſtance. The ſatellites alſo, in conſequence of the ſame principle, attract the planets and the ſun according to the ſame law. This attracting force is then common to all the heavenly bodies.

This force does not diſturb the elliptical motion of the planets round the ſun, when we conſider only their mutual action. For the relative movement of a ſyſtem of bodies does not change by giving them a common motion. Neither is the elliptical motion of the ſatellites diſturbed by the revolution of the planets round the ſun, for the very ſame reaſon.

The attractive force does not belong to theſe bodies only as wholes; but it belongs to every particle of matter of which each of them is compoſed. If the ſun acted only upon the centre of the earth, without attracting every one of the particles of which it is compoſed individually, there would reſult *tides* incomparably greater, and very different from thoſe that we observe. Besides, every body on the earth gravitates towards its centre, in proportion to its mass. It reacts of course upon the earth, and attracts it in the same ratio. Unless that were the case, or if any part of the earth, however small, did not attract the other part as it is attracted by it, the centre of gravity of the earth would be moved in space, in consequence of gravitation; which is impossible.

355 General law of gravitation.

All these phenomena, compared with the laws of motion, lead us to this grand conclusion: *All the particles of matter mutually attract each other, in proportion to their masses, and inversely as the squares of their distances.* This is called *universal gravitation*, and was the discovery which crowned the happy industry, the consummate skill, and the unrivalled sagacity of Newton.

In universal gravitation, we readily perceive a cause of the irregularities and disturbances perceptible in the planetary motions. For as the planets and comets act upon each other, they ought to deviate a little from that exact ellipticity, which they would follow if they obeyed only the action of the sun. The satellites, disturbed equally by their mutual attraction, and by that of the sun, must deviate also from these laws. We see also, that the particles of which each heavenly body is composed, provided they be at liberty to move, ought to form themselves into a sphere, and that the result of their mutual action at the surface of this sphere ought to produce all the phenomena of gravity. We see also, that the rotation of the heavenly bodies round an axis ought to alter this sphericity somewhat by flattening them at the poles, and that the result of their mutual action not passing exactly through their centres of gravity, ought to produce in their axis of rotation motions similar to those which we perceive. We see also, that the particles of the ocean, unequally attracted by the sun and moon, ought to have an oscillation similar to the tides. But it will be necessary to consider the effects of gravitation more particularly; in order to show that it is established in the completest manner by all the phenomena. This shall be the subject of the next chapter.

Chap. III. *Of the Effects of Gravitation.*

We shall in this chapter consider, in the first place, several points which could only be ascertained by the assistance of gravitation, and afterwards examine the several subjects hinted at towards the conclusion of the last chapter.

Sect. I. *Of the Masses of the Planets.*

It would appear, at first view, impossible to ascertain the respective masses of the sun and planets, and to calculate the velocity with which heavy bodies fall towards each when at a given distance from their centres; yet these points may be determined from the theory of gravitation without much difficulty.

356 Calculation of the densities of the planets.

It follows from the theorems relative to centrifugal forces, given in the first chapter of this part, that the gravitation of a satellite towards its planet is to the gravitation of the earth towards the sun as the mean distance of the satellite from its primary, divided by the square of the time of its sidereal revolution, or the mean distance of the earth from the sun divided by the square of a sidereal year. To bring these gravitations to the same distance from the bodies which produce them, we must multiply them respectively by the squares of the radii of the orbits which are described: and, as at equal distances the masses are proportional to the attractions, the mass of the earth is to that of the sun as the cube of the mean radius of the orbit of the satellite, divided by the square of the time of its sidereal motion, is to the cube of the mean distance of the earth from the sun, divided by the square of the sidereal year.

Let us apply this result to Jupiter. The mean distance of his 4th satellite subtends an angle of 1530″.86 decimal seconds. Seen at the mean distance of the earth from the sun, it would appear under an angle of 7964″.75 decimal seconds. The radius of the circle contains 636619″.8 decimal seconds. Therefore the mean radii of the orbit of Jupiter's 4th satellite and of the earth's orbit are to each other as these two numbers. The time of the sidereal revolution of the 4th satellite is 16.6890 days; the sidereal year is 365.2564 days. These data give us $\frac{1}{1066.08}$ for the mass of Jupiter, that of the sun being represented by 1. It is necessary to add unity to the denominator of this fraction, because the force which retains Jupiter in his orbit is the sum of the attractions of Jupiter and the sun. The mass of Jupiter is then $\frac{1}{1067.08}$. The mass of Saturn and Herschel may be calculated in the same manner. That of the earth is best determined by the following method:

If we take the mean distance of the earth from the sun for unity, the arch described by the earth in a second of time will be the ratio of the circumference to the radius divided by the number of seconds in a sidereal year. If we divide the square of that arch by the diameter, we obtain $\frac{1479565}{10^{20}}$ for its versed sine, which is the deflection of the earth towards the sun in a second. But on that parallel of the earth's surface the square of the sine of whose latitude is $\frac{1}{3}$, a body falls in a second $16\frac{1}{8}$ feet. To reduce this attraction to the mean distance of the earth from the sun, we must divide the number by the feet contained in that distance; but the radius of the earth at the above mentioned parallel is 19614648 French feet. If we divide this number by the tangent of the solar parallax, we obtain the mean radius of the earth's orbit expressed in feet. The effect of the attraction of the earth at a distance equal to the mean radius of its orbit, is equal to $\frac{16\frac{1}{8}}{19614648}$ multiplied by the cube of the tangent of the solar parallax $= \frac{1479560.5}{10^{20}}$. Hence the masses of the sun and earth are to each other as the numbers 1479560.5 and 4.486113; therefore the mass of the earth is $\frac{1}{329809}$, that of the sun being unity.

M. de la Place calculated the masses of Mars and Venus from the secular diminution of the obliquity of the ecliptic, and from the mean acceleration of the moon's motion. The mass of Mercury he obtained from its volume, supposing the densities of that planet and

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and of the earth reciprocally as their mean distance from the sun, a rule which holds, with respect to the earth, Jupiter, and Saturn. The following table exhibits the masses of the different planets, that of the sun being unity:

357 Table of the masses.

Mercury -	$\frac{1}{2025810}$
Venus - -	$\frac{1}{383137}$
Earth - -	$\frac{1}{329809}$
Mars - -	$\frac{1}{1846082}$
Jupiter - -	$\frac{1}{1067.09}$
Saturn - -	$\frac{1}{3359.40}$
Herschel - -	$\frac{1}{19504}$

The densities of bodies are proportional to their masses divided by their bulks; and, when bodies are nearly spherical, their bulks are as the cubes of their semidiameters, of course the densities in that case are as the masses divided by the cubes of the semidiameters. For greater exactness, we must take that semidiameter of a planet which corresponds to the parallel, the square of the sine of which is equal to $\frac{1}{3}$, and which is equal to the third of the sum of the radius of the pole, and twice the radius of the equator. This method gives us the densities of the principal planets as follows, that of the sun being unity:

358 Of their densities.

Earth	3.93933
Jupiter	0.86014
Saturn	0.49512
Herschel	1.13757.

359 Of gravity at their surfaces.

To have the intensity of gravitation at the surface of the sun and planets, let us consider, that, if Jupiter and the earth were exactly spherical, and destitute of their rotatory motion, gravitation at their equators would be proportional to the masses of these bodies divided by the squares of their diameters. But at the mean distance of the sun from the earth, the diameters of the equators of Jupiter and of the earth are to each other as the numbers 626.26 and 54.5. If then we represent the weight of a body at the earth's equator by 1, the same body, if transported to the equator of Jupiter, would weigh 2.509. But the difference of the centrifugal forces on the surface of the earth and Jupiter renders it necessary to diminish this last number by about $\frac{1}{9}$. The same body at the surface of the sun would weigh 27.65.

Sect. II. *Of the Perturbations in the Elliptical Orbit of the Planets.*

If the planets were influenced only by the sun, they would describe ellipses round that luminary: but they act upon one another, and from these various attractions there result disturbances in their elliptical motions, discoverable by observation, and which it is necessary to determine, in order to be able to construct accurate tables of the planetary motions. The rigorous solution of this problem is above the reach of the mathematical analysis; mathematicians have been obliged to satisfy themselves with approximations.

360 Secular and periodical inequalities.

The disturbances in the elliptical motions of the planets may be divided into two classes. The first class affects the elements of the elliptical motion: they increase very slowly, and have been called *secular* inequalities. The other class depends upon the configuration of the planets, either with respect to each other, or with respect to their nodes and perihelions, and are renewed every time that the relative situation of the planets becomes the same. They are called *periodical* inequalities, to distinguish them from the *secular*, whose periods are much longer and altogether independent of the mutual configuration of the planets. Before proceeding farther, we beg leave to introduce the following quotation from Dr Pemberton, because it will convey some notion of these disturbances in a very familiar manner to our readers.

"The only inequalities which have been observed common to all the planets are, the motion of the aphelion and the nodes. The transverse axis of each orbit does not remain always fixed, but moves about the sun with a very slow progressive motion; nor do the planets keep constantly in the same planes, but change them and the lines by which these planes intersect each other by insensible degrees. The first of these inequalities, 361 Motion of the aphelion accounted for.
which is the motion of the aphelion, may be accounted for, by supposing the gravitation of the planets towards the sun to differ a little farther from the forementioned reciprocal duplicate proportion of the distances; but the second, which is the motion of the nodes, cannot be accounted for by any power directed towards the sun; for no such power can give it any lateral impulse to divert it from the plane of its motion into any new plane, but of necessity must be derived from some other centre. Where that power is lodged, remains to be discovered. Now it is proved, as shall afterwards be explained, that the three primary planets, Saturn, Jupiter, and the Earth, which have satellites revolving about them, are endowed with a power of causing bodies, in particular those satellites, to gravitate towards them with a force which is reciprocally in the duplicate proportion of their distances; and the planets are, in all respects in which they come under our consideration, so similar and alike, that there is no reason to question but they have all the same property, though it be sufficient for the present purpose to have it proved of Jupiter and Saturn only; for these planets contain much greater quantities of matter than the rest, and proportionally exceed the others in power. But the influence of these two planets being allowed, it is evident how the planets come to shift their places continually; for each of the planets moving in a different plane, the action of Jupiter and Saturn upon the rest will be oblique to the planes of their motion, and therefore will gradually draw them into new ones. The same action of these two planets upon the rest will likewise cause a progressive motion; and therefore will gradually draw them into new ones. The same action of these two planets upon the rest will likewise cause a progressive motion of the aphelion; so that there will be no necessity for having recourse to the other cause for this motion, which was before hinted at, viz. the gravitation of the planets toward the sun differing from the exact duplicate proportion

portion of their diſtances. And, in the laſt place, the action of Jupiter and Saturn upon each other will produce in their motions the ſame inequalities as their joint action produces upon the reſt. All this is effected in the ſame manner as the ſun produces the ſame kind of inequalities and many others in the motion of the moon and other ſecondary planets; and therefore will be beſt apprehended by what is ſaid afterwards. Thoſe other irregularities in the motion of the ſecondary planets have place likewiſe here, but are too minute to be obſervable, becauſe they are produced and rectified alternately, for the moſt part in the time of a ſingle revolution; whereas the motion of the

362 Jupiter and Saturn influence each other's motions.

aphelion and nodes which increaſe continually, become ſenſible after a long ſeries of years. Yet ſome of theſe other inequalities are diſcernible in Jupiter and Saturn; in Saturn chiefly: for when Jupiter, who moves faſter than Saturn, approaches to a conjunction with him, his action upon the latter will a little retard the motion of that planet; and by the reciprocal action of Saturn, he will himſelf be accelerated. After conjunction, Jupiter will again accelerate Saturn, and be likewiſe retarded in the ſame degree as before the firſt was retarded and the latter accelerated. Whatever inequalities beſides are produced in the motion of Saturn by the action of Jupiter upon that planet, will be ſufficiently rectified by placing the focus of Saturn's ellipſis, which ſhould otherwiſe be in the ſun, in the common centre of gravity of the ſun and Jupiter. And all the inequalities of Jupiter's motions, cauſed by the action of Saturn upon him, are much leſs conſiderable than the irregularities of Saturn's motion. This one principle, therefore, of the planets having a power as well as the ſun to cauſe bodies gravitate towards them, which is proved by the motion of the ſecondary planets to obtain in fact, explains all the irregularities relating to the planetary motions ever obſerved by aſtronomers (c).

363 Method of correcting the planetary motions.

"Sir Iſaac Newton after this proceeds to make an improvement in aſtronomy, by applying this theory to the farther correction of their motions. For as we have here obſerved the planets to poſſeſs a principle of gravitation as well as the ſun; ſo it will be explained at large hereafter, that the third law of motion, which makes action and reaction equal, is to be applied in this caſe, and that the ſun does not only attract each planet, but is alſo itſelf attracted by them; the force wherewith the planet is acted on, bearing to the force wherewith the ſun itſelf is acted upon at the ſame time, the proportion which the quantity of matter in

364 Sun moves round the common centre of gravity of him and the planets.

the ſun bears to the quantity of matter in the planet. From the action of the ſun and planet being thus mutual, Sir Iſaac Newton proves that the ſun and planet will deſcribe about their common centre of gravity ſimilar ellipſes; and then, that the tranſverſe axis of the ellipſis, which would be deſcribed about the ſun at reſt in the ſame time, the ſame proportion as the quantity of ſolid matter in the ſun and planet together bears to the firſt of two mean proportionals between this quantity and the quantity of matter in the ſun only.

"It will be aſked, perhaps, how this correction can be admitted, when the cauſe of the motions of the planets was before found, by ſuppoſing them to be the centre of the power which acted upon them? for, according to the preſent correction, this power appears rather to be directed to the common centre of gravity. But whereas the ſun was at firſt concluded to be the centre to which the power acting on the planets was directed, becauſe the ſpaces deſcribed in equal times round the ſun were found to be equal; ſo Sir Iſaac Newton proves, that if the ſun and planet move round their common centre of gravity, yet, to an eye placed in the planet, the ſpaces which will appear to be deſcribed about the ſun will have the ſame relation to the times of their deſcription as the real ſpaces would if the ſun were at reſt. I further aſſerted, that, ſuppoſing the planets to move round the ſun at reſt, and to be attracted by a power which ſhould everywhere act with degrees of ſtrength reciprocally in the duplicate proportions of their diſtances; then the periods of the planets muſt obſerve the ſame relations to their diſtances as aſtronomers have found them to do. But here it muſt not be ſuppoſed, that the obſervations of aſtronomers abſolutely agree without any the leaſt difference: and the preſent correction will not cauſe a deviation from any one aſtronomer's obſervations ſo much as they differ from one another; for in Jupiter, where this correction is greateſt, it hardly amounts to the 3000th part of the whole axis.

365 Argument againſt the eternity of the world.

"Upon this head, I think it not improper to mention a reflection made by our excellent author upon theſe ſmall inequalities in the planets motions, which contains in it a very ſtrong philoſophical argument againſt the eternity of the world. It is this, that theſe inequalities muſt continually increaſe by ſlow degrees, till they render at length the preſent frame of nature unfit for the purpoſes it now ſerves. And a more convincing proof cannot be deſired againſt the preſent conſtitution's having exiſted from eternity than this, that a certain period of years will bring it to an end. I am aware, that this thought of our author has been repreſented even as impious, and as no leſs than caſting a reflection upon the wiſdom of the Author of nature for framing a periſhable work. But I think ſo bold an aſſertion ought to have been made with ſingular caution: for if this remark upon the increaſing irregularities in the heavenly motions be true in fact, as it really is, the imputation muſt return upon the aſſertor, that this does not detract from the divine wiſdom. Certainly we cannot pretend to know all the omniſcient Creator's purpoſes in making this world, and therefore cannot pretend to determine how long he deſigned it ſhould laſt; and it is ſufficient if it endure the time deſigned by the Author. The body of every animal ſhows

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(c) Profeſſor J. Robiſon, however, informs us in his paper on the *Georgium Sidus* (Edinburgh Philoſophical Tranſactions, Vol. I.), That *all* the irregularities in the planetary motions *cannot* be accounted for from the laws of gravitation; for which reaſon he was obliged to ſuppoſe the exiſtence of planets beyond the orbit of Saturn, even before the diſcovery of the *Georgium Sidus*. M. de la Lande alſo has obſerved ſome unaccountable inequalities in the motion of Saturn for more than 30 years paſt.

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ſhows the unlimited wiſdom of the Author no leſs, nay, in many reſpects more, than the larger frame of nature: and yet we ſee they are all deſigned to laſt but a ſmall ſpace of time."

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Deflection of the planets towards each other.

Sir Iſaac Newton had no ſooner diſcovered the univerſality and reciprocity of the deflections of the planets and the ſun, than he alſo ſuſpected that they were continually deflected towards each other. He immediately obtained a general notion of what ſhould be the more general reſults of ſuch a mutual action. They may be conceived in this way.

Let S (fig. 135.) repreſent the ſun, E the earth, and I Jupiter, deſcribing concentric orbits round the centre of the ſyſtem. Make $IS : EA = EI^2 : SI^2$. Then, if IS be taken to repreſent the deflection of the ſun toward Jupiter, EA will repreſent the deflection of the Earth to Jupiter. Draw EB equal and parallel to SI, and complete the parallelogram EBAD. ED will repreſent the diſturbing force of Jupiter. It may be reſolvent into EF, perpendicular to ES, and EG in the direction of SE. By the firſt of theſe the earth's angular motion round the ſun is affected, and by the ſecond its deflection toward him is diminiſhed or increaſed.

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General reſult of ſuch mutual action.

In conſequence of this firſt part of the diſturbing force, the angular motion is increaſed, while the earth approaches from quadrature to conjunction with Jupiter (which is the caſe repreſented in the figure), and is diminiſhed from the time that Jupiter is in oppoſition till the earth is again in quadrature, weſtward of his oppoſition. The earth is then accelerated till Jupiter is in conjunction with the ſun; after which it is retarded till the earth is again in quadrature.

The earth's tendency to the ſun is diminiſhed while Jupiter is in the neighbourhood of his oppoſition or conjunction, and increaſed while he is in the neighbourhood of his ſtationary poſitions. Jupiter being about 1000 times leſs than the ſun, and 5 times more remote, IS muſt be conſidered as repreſenting $\frac{1}{25000}$th of the earth's deflection to the ſun, and the forces ED and EG are to be meaſured on this ſcale.

In conſequence of this change in the earth's tendency to the ſun, the aphelion ſometimes advances by the diminution, and ſometimes retreats by the augmentation. It advances when Jupiter chances to be in oppoſition when the earth is in its aphelion; becauſe this diminution of its deflection towards the ſun makes it later before its path is brought from forming an obtuſe angle with the *radius vector*, to form a right angle with it. Becauſe the earth's tendency to the ſun is, on the whole, more diminiſhed by the diſturbing force of Jupiter than it is increaſed, the aphelion of the earth's orbit advances on the whole.

In like manner the aphelia of the inferior planets advance by the diſturbing forces of the ſuperior: but the aphelion of a ſuperior planet retreats; for theſe reaſons, and becauſe Jupiter and Saturn are larger and more powerful than the inferior planets, the aphelia of them all advance while that of Saturn retreats.

In conſequence of the ſame diſturbing forces, the node of the diſturbed planet retreats on the orbit of the diſturbing planet; therefore they all retreat on the ecliptic, except that of Jupiter, which advances by retreating on the orbit of Saturn, from which it ſuffers the greateſt diſturbance. This is owing to the particular poſition of the nodes and the inclinations of the orbits.

The inclination of a planetary orbit increaſes while the planet approaches the node, and diminiſhes while the planet retires from it.

368
A peculiarity explained in the motions of Jupiter and Saturn.

M. de la Place has completed this deduction of the planetary inequalities, by explaining a peculiarity in the motions of Jupiter and Saturn, which has long employed the attention of aſtronomers. The accelerations and retardations of the planetary motions depend, as has been ſhown, on their configurations, or the relative quarters of the heavens in which they are. Thoſe of Mercury, Venus, the Earth, and Mars, ariſing from their mutual deflections; and their more remarkable deflections to the great planets Jupiter and Saturn, nearly compenſate each other, and no traces of them remain after a few revolutions: but the poſitions of the aphelia of Saturn and Jupiter are ſuch, that the retardations of Saturn ſenſibly exceed the accelerations, and the anomaliſtic period of Saturn increaſes almoſt a day every century; on the contrary, that of Jupiter diminiſhes. M. de la Place ſhows, that this proceeds from the poſition of the aphelia, and the almoſt perfect commenſurability of their revolutions; five revolutions of Jupiter making 21,675 days, while two revolutions of Saturn make 21,538, differing only 137 days.

Suppoſing this relation to be exact, the theory ſhews, that the mutual action of theſe planets muſt produce mutual accelerations and retardations of their mean motions, and aſcertains the periods and limits of the ſecular equations thence ariſing. Theſe periods include ſeveral centuries. Again, becauſe this relation is not preciſe, but the odd days nearly divide the periods already found, there muſt ariſe an equation of this ſecular equation, of which the period is immenſely longer, and the maximum very minute. He ſhews that this retardation of Saturn is now at its maximum, and is diminiſhing again, and will, in the courſe of years, change to an acceleration.

This inveſtigation of the ſmall inequalities is the moſt intricate problem in mechanical philoſophy, and has been completed only by very ſlow degrees, by the arduous efforts of the greateſt mathematicians, of whom M. de la Grange is the moſt eminent. Some of his general reſults are very remarkable.

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Oſcillation of the planetary ſyſtem.

He demonſtrates, that ſince the planets move in one direction, in orbits nearly circular, no mutual diſturbances make any permanent change in the mean diſtances and mean periods of the planets, and that the periodic changes are confined within very narrow limits. The orbits can never deviate ſenſibly from circles. None of them ever has been or will be a comet moving in a very eccentric orbit. The ecliptic will never coincide with the equator, not change its inclination above two degrees. In ſhort, the ſolar planetary ſyſtem oſcillates, as it were, round a medium ſtate, from which it never ſwerves very far.

This theory of the planetary inequalities, founded on the univerſal law of mutual deflection, has given to our tables a preciſion, and a coincidence with obſervation, that ſurpaſſes all expectation, and inſures the legitimacy of the theory. The inequalities are moſt ſenſible in the motions of Jupiter and Saturn; and theſe preſent themſelves in ſuch a complicated ſtate, and their periods are ſo long, that ages were neceſſary for diſcovering them

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by mere observation. In this respect, therefore, the theory has outstripped the observations on which it is founded. It is very remarkable, that the periods which the Indians assign to these two planets, and which ap-
370 Authenticity of the Indian astronomy. peared so inaccurate that they hurt the credit of the science of those ancient astronomers, are now found precisely such as must have obtained about three thousand years before the Christian era; and thus they give an authenticity to that ancient astronomy. The periods which any nation of astronomers assign to those two planets would afford no contemptible mean for determining the age in which it was observed.

The following circumstance pointed out by La Place is remarkable: Suppose Jupiter and Saturn in conjunction in the first degree of Aries; twenty years after, the conjunction will happen in Sagittarius; and after other twenty years, in Leo. It will continue in these three signs for 200 years. In the next 200 it will happen in Taurus, Capricornus, and Virgo; in the next 200 years, it will happen in Gemini, Aquarius, and Libra; and in the next
371 Origin of the astrological division of the heavens. 200 years, it will happen in Cancer, Pisces, and Scorpio: then all begins again in Aries. It is probable that these remarkable periods of the oppositions of Jupiter and Saturn, progressive for 40 years, and oscillating during 160 more, occasioned the astrological division of the heavens into the four *trigons*, of fire, air, earth, and water. These relations of the signs, which compose a trigon, point out the repetitions of the chief irregularities of the solar system.

M. de la Place observes (in 1796), that the planet Herschel gives evident marks of the action of the rest; and that when these are computed and taken into the account of its bygone motions, they put it beyond doubt that it was seen by Flamstead in 1690, by Mayer in 1756, and by Monnier in 1769.

Sect. III. *Of the Disturbances in the Elliptical Motion of the Comets.*

Before the time of Sir Isaac Newton it was supposed that they moved in straight lines: and Descartes, finding that such a motion would interfere with his vortices,
372 Comets generally invisible until they come nearer than Jupiter. removed them entirely out of the solar system. Sir Isaac Newton, however, distinctly proves from astronomical observation, that the comets pass through the planetary regions, and are generally invisible at a smaller distance than that of Jupiter. Hence, finding that they were evidently within the sphere of the sun's action, he concludes, that they must necessarily move about the sun as the planets do: and he proves, that the power of the sun being reciprocally in the duplicate proportion of the distance, every body acted upon by him must either fall directly down, or move about him in one of the conic sections; viz. either the ellipsis, parabola, or hyperbola. If a body which descends towards the sun as low as the orbit of any planet, move with a swifter motion than the planet, it will describe an orbit of a more oblong figure than that of the planet, and have at least a longer axis. The velocity of the body may be so great, that it shall move in a parabola, so that having once passed the sun, it shall ascend for ever without returning, though the sun will still continue in the focus of that parabola; and with a velocity still greater, they will move in an hyperbola. It is, however, most probable, that the comets move in very eccentric ellipses, such as is represented in fig. 136. where S represents the sun, C the comet, and ABDE its orbit; wherein the distance of S and D far exceeds that of S and A. Hence those bodies are sometimes found at a moderate distance from the sun, and appear within the planetary regions; at other times they ascend to vast distances, far beyond the orbit of Saturn, and thus become invisible.

That the comets do move in this manner is pro- 373 They move in eccentric ellipses.
ved by our author from computations built upon the observations made by many astronomers. These computations were made by Sir Isaac Newton himself upon the comet which appeared toward the latter end of the year 1680 and beginning of 1681, and the same were prosecuted more at large by Dr Halley upon this and other comets. They depend on this principle, that the eccentricity of the orbits of the comets is so great, that if they are really elliptical, yet that part of them which comes under our view approaches so near to a parabola that they may be taken for such without any sensible error, as in the foregoing figure the parabola FAG, in the lower part of it about A, differs very little from the ellipsis DEAB; on which foundation Sir I- 374 How to calculate the motion of a comet.
saac teaches a method of finding the parabola in which any comet moves, by three observations made upon it in that part of its orbit where it agrees nearest with a parabola: and this theory is confirmed by astronomical observations; for the places of the comets may thus be computed as exactly as those of the primary planets. Our author afterwards shows how to make use of any small deviation from the parabola which may be observed, to determine whether the orbits of the comets be elliptical or not; and thus to know whether or not the same comet returns at different seasons. On examining by this rule the comet of 1680, he found its orbit to agree more exactly with an ellipsis than a parabola, though the ellipsis be so very eccentric, that it cannot perform its revolution in 500 years. On this Dr Halley observed, that mention is made in history of a comet with a similar large tail, which appeared three several times before. The first was before the death of Julius Cæsar; and each appearance happened at the interval of 575 years, the last coinciding with the year 1680. He therefore calculated the motion of this comet to be in such an eccentric orbit, that it could not return in less than 575 years: which computation agrees yet more perfectly with the observations made on this comet than any parabolic orbit will do. To compare together different appearances of the same comet, is indeed the only method of discovering with certainty the form of its orbit; for it is impossible to discover the form of one so exceedingly eccentric from observations taken in a small part of it. Sir Isaac Newton therefore proposes to compare the orbits, on the supposition that they are parabolical, of such comets as appear at different times; for if we find the same orbit described by a comet at different times, in all probability it will be the same comet that describes it. Here he remarks from Dr Halley, that the same orbit very nearly agrees to two appearances of a comet about the space of 75 years distance; so that if these two appearances were really of the same comet, the transverse axis of its orbit would be 18 times that of the axis of the earth's orbit; and therefore, when at its greatest distance from the sun, this comet would be removed not less than 35 times the mean distance of the earth from the same luminary.

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375 They are affected by the planets.

The comets may be considerably affected by the planets. The very important phenomenon of the return of the comet of 1682, which was to decide whether they were revolving planets describing ellipses, or bodies which come but once into the planetary regions, and then retire for ever, caused the astronomers to consider this matter with great care. Halley had shown, in a rough way, that this comet must have been considerably affected by Jupiter. Their motion near the aphelion must be very slow, that a very small change of velocity or direction, while in the planetary regions, must considerably affect ther periods. Halley thought that the action of Jupiter might change it half a year. M. Clairaut, by considering the disturbing forces of Jupiter and Saturn through the whole revolution, showed that the period then running would exceed the former nearly two years (618 days), and assigned the middle of April 1759 for the time of its perihelion. It really passed its perihelion on the 12th of March. This was a wonderful precision, when we reflect that the comet had been seen but a very few days in its former apparitions.

A comet observed by Mr Prosperin and others in 1771 has greatly puzzled the astronomers. Its motions appear to have been extremely irregular, and it certainly came so near Jupiter, that his momentary influence was at least equal to the sun's. It has not been recognised since that time, although there is a great probability that it is continually among the planets.

376 Consequence of a comet and planet meeting.

It is by no means impossible, that, in the course of ages, a comet may actually meet one of the planets. The effect of such a concourse must be dreadful; a change of the axis of diurnal rotation must result from it, and the sea must desert its former bed and overflow the new equatorial regions. The shock and the deluge must destroy all the works of man, and most of the race. The remainder, reduced to misery, must long struggle for existence, and all remembrance of former arts and events must be lost, and every thing must be invented anew. There are not wanting traces of such devastations in this globe: strata and things are now found on mountain tops which were certainly at the bottom of the ocean in former times; remains of tropical animals and plants are now dug up in the circumpolar regions.

Sect. IV. *Of the Irregularities in the Moon's Motion.*

The moon is acted on at once by the sun and the earth: but her motion round the earth is only disturbed by the difference of the sun's action on these two bodies. If the sun were at an infinite distance it would act upon them both equally and in a parallel direction; of course, their relative motion would not be disturbed. But its distance though very great, when compared with that of the moon, cannot be considered as infinite. The moon is alternately nearer and farther from the sun than the earth, and the straight line which joins the centre of the sun and moon forms angles more or less acute with the radius vector of the earth. Of course the sun acts unequally, and in different directions, upon the earth and moon; and from that diversity of action, there ought to result irregularities in the lunar motions, depending on the respective situation of the sun and moon.

Some of these inequalities, however, would take place, though the moon if undisturbed by the sun had moved in a circle concentrical to the earth, and in the plane of the earth's motion; others depend on the elliptical figure and oblique situation of the moon's orbit. One of the former is, that the moon does not describe equal spaces in equal times, but is continually accelerated as she passes from the quarter to the new or full, and is retarded again by the like degrees in returning from the new and full to the next quarter: but here we consider not so much the absolute as the apparent motions of the moon with respect to us. These two may be distinguished in the following manner: Let S in fig. 137. represent the sun, A the earth moving in its orbit BC, DEFG the moon's orbit, and H the place of the moon in her orbit. Suppose the earth to have moved from A to I. Because it has been shown that the moon partakes of all the progressive motion of the earth, and likewise that the sun attracts both the earth and moon equally when they are at the same distance from it, or that the mean action of the sun upon the moon is equal to its action upon the earth; we must therefore consider the moon as carrying about with it the moon's orbit: so that when the earth is removed from A to I, the moon's orbit shall likewise be removed from its former situation into that denoted by KLMN. But now the earth being in I, if the moon were found in O, so that OI should be parallel to HA, though the moon would really have moved from H to O, yet it would not have appeared to a spectator upon the earth to have moved at all, because the earth has moved as much as itself; so that the moon would still appear in the same place with respect to the fixed stars. But if the moon be observed in P, it will then appear to have moved, its apparent motion being measured by the angle under OIP. And if the angle under PIS be less than the angle under HAS, the moon will have approached nearer its conjunction with the sun. Now, to explain particularly the inequality of the moon's motion already mentioned, let S in fig. 138. represent the sun, A the earth, BCDE the moon's orbit, C the place of the moon when in the latter quarter. Here it will be nearly at the same distance from the sun as the earth is. In this case, therefore, they will be both equally attracted, the earth in the direction AS, and the moon in that of CS. Whence, as the earth, in moving round the sun, is continually descending towards it, so the moon in this situation must in any equal portion of time descend as much; and therefore the position of the line AC in respect of AS, and the change which the moon's motion produces in the angle CAS, will not be altered by the sun: but as soon as the moon is advanced from the quarter towards the new or conjunction, suppose to G, the action of the sun upon it will have a different effect. Were the sun's action upon the moon here to be applied in the direction GH parallel to AS, if its action on the moon were equal to its action on the earth, no change would be wrought by the sun on the apparent motion of the moon round the earth. But the moon receiving a greater impulse in G than the earth receives in A, were the sun to act in the direction GH, yet it would accelerate the description of the space DAG, and cause the angle under GAD to decrease faster than it otherwise would. The sun's action will have this effect upon account of the obliquity

377 Inequalities of the moon's motion explained.

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quity of its direction to that in which the earth attracts the moon. For the moon by this means is drawn by two forces oblique to one another; one drawing from G towards A, the other from G towards H; therefore the moon must necessarily be impelled toward D. Again, because the sun does not act in the direction GH parallel to SA, but in the direction GS oblique to it, the sun's action on the moon will, by reason of this obliquity, farther contribute to the moon's acceleration. Suppose the earth, in any short space of time, would have moved from A to I, if not attracted by the sun, the point I being in the straight line CE, which touches the earth's orbit in A. Suppose the moon in the same time would have moved in her orbit from G to K, and besides have partook of all the progressive motion of the earth. Then, if KL be drawn parallel to AI, and taken equal to it, the moon, if not attracted to the sun, would be found in L. But the earth, by the sun's action, is removed from I. Suppose it were moved down to M in the line IMN parallel to SA, and if the moon were attracted but as much, and in the same direction as the earth is here supposed to be attracted, so as to have descended during the same time in the line LO parallel also to AS, down as far as P, till LP were equal to IM, the angle under PMN would be equal to that under LIN; that is, the moon will appear advanced as much farther forward than if neither it nor the earth had been subject to the sun's action. But this is on the supposition that the actions of the sun upon the earth and moon are equal; whereas the moon being acted upon more than the earth, did the sun's action draw the moon in the line LO parallel to AS, it would draw it down so far as to make LP greater than IM, whereby the angle under PMN will be rendered greater than that under LIN. But, moreover, as the sun draws the earth in a direction oblique to IN, the earth will be found in its orbit somewhat short of the point M. However, the moon is attracted by the sun still more out of the line LO than the earth is out of the line IN; therefore this obliquity of the sun's action will yet farther diminish the angle under PMN. Thus the moon at the point G receives an impulse from the sun whereby her motion is accelerated; and the sun producing this effect in every place between the quarter and the conjunction, the moon will move from the quarter with a motion continually more and more accelerated; and therefore, by acquiring from time to time an additional degree of velocity in its orbit, the spaces which are described in equal times by the line drawn from the earth to the moon will not be everywhere equal, but those toward the conjunction will be greater than those toward the quarter. But in the moon's passage from the conjunction D to the next quarter, the sun's action will again retard the moon, till, at the next quarter at E, it be restored to the first velocity which it had in C. When the moon moves from E to the full, or opposition to the sun in B, it is again accelerated; the deficiency of the sun's action on the moon from what it has upon the earth producing here the same effect as before the excess of its action.

Let us now consider the moon in Q as moving from E towards B. Here, if she were attracted by the sun in a direction parallel to AS, yet being acted on less than the earth, as the latter descends towards the sun, the moon will in some measure be left behind. Therefore, QF being drawn parallel to SB, a spectator on the earth would see the moon move as if attracted from the point Q in the direction QF, with a degree of force equal to that whereby the sun's action on the moon falls short of its action on the earth. But the obliquity of the sun's action has here also an effect. In the time the earth would have moved from A to I without the influence of the sun, let the moon have moved in its orbit from Q to R. Drawing, therefore, RT parallel and equal to AI, the moon, by the motion of its orbit, if not attracted by the sun, must be found in T: and therefore, if attracted in a direction parallel to SA, would be in the line TV parallel to AS; suppose in W. But the moon in Q being farther off the sun than the earth, it will be less attracted; that is, TW will be less than IM; and if the line SM be prolonged towards X, the angle under XMW will be less than XIT. Thus, by the sun's action, the moon's passage from the quarter to the full would be accelerated, if the sun were to act on the earth and moon in a direction parallel to AS; and the obliquity of the sun's action will still increase this acceleration: For the action of the sun on the moon is oblique to the line SA the whole time of the moon's passage from Q to T, and will carry her out of the line TV towards the earth. Here we suppose the time of the moon's passage from Q to T so short, that it shall not pass beyond the line SA. The earth will also come a little short of the line IN, as was already mentioned; and from these causes the angle under XMW will be still farther lessened. The moon, in passing from the opposition B to the next quarter, will be retarded again by the same degrees as it was accelerated before its appulse to the opposition; and thus the moon, by the sun's action upon it, is twice accelerated and twice restored to its first velocity every circuit it makes round the earth; and this inequality of the moon's motion about the earth is called by astronomers its variation.

378 Effect of the sun's attraction in different parts of the moon's orbit.

The next effect of the sun upon the moon is, that it gives the orbit of the latter in the quarters a greater degree of curvature than it would receive from the earth alone: and, on the contrary, in the conjunction and opposition the orbit is less inflected. When the moon is in the conjunction with the sun at D, the latter attracting her more forcibly than it does the earth, the moon is by that means impelled less to the earth than otherwise it would be, and thus the orbit is less incurvated; for the power by which the moon is impelled towards the earth being that by which it is inflected from a rectilinear course, the less that power is, the less it will be inflected. Again, when the moon is in the opposition in B farther removed from the sun than the earth is, it follows, then, that though the earth and moon are both continually descending toward the sun, that is, are drawn by the sun towards itself out of the place they would otherwise move into, yet the moon descends with less velocity than the earth: insomuch that, in any given space of time from its passing the point of opposition, it will have less approached the earth than otherwise it would have done; that is, its orbit, in respect to the earth, will approach nearer to a straight line. Lastly, when the motion is in the quarter in F, and equally distant from the sun as the earth, it

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it was before observed, that they would both descend with equal velocity towards the sun, so as to make no change in the angle FAS; but the length of the line FA must necessarily be shortened. Therefore the moon, in moving from F toward the conjunction with the sun, will be impelled more toward the earth by the sun's action than it would have been by the earth alone, if neither the earth nor the moon had been acted upon by the sun: so that, by this additional impulse, the orbit is rendered more curve than it otherwise should be. The same effect will also be produced in the other quarter.

379 Moon comes nearest the earth when least attracted by it.

A third effect of the sun's action, and which follows from that just now explained, is, that though the moon undisturbed by the sun might move in a circle, having the earth for its centre, by the sun's action, if the earth were to be in the very middle or centre of the moon's orbit, yet the moon would be nearer the earth at the new and full than in the quarters. This may at first appear somewhat difficult to be understood, that the moon should come nearest to the earth when it is least attracted by it; yet, upon a little consideration, it will evidently appear to flow from that very cause, because her orbit, in the conjunction and opposition, is rendered less curve; for the less curve the orbit is, the less will the moon have descended from the place it would move into without the action of the earth. Now, if the moon were to move from any place without further disturbance from that action, since it would proceed on the line touching the orbit in that place, it would continually recede from the earth; and therefore, if the power of the earth upon the moon be sufficient to retain it at the same distance, this diminution of that power will cause the distance to increase, though in a less degree. But, on the other hand, in the quarters, the moon being pressed in a less degree towards the earth than by the earth's single action, will be made to approach it: so that, in passing from the conjunction or opposition to the quarters, the moon ascends from the earth; and in passing from the quarters to the opposition or conjunction, it descends again, becoming nearer in these last mentioned places than in the other.

380 Cause of the dilatation of the moon's orbit.

All the inequalities we have mentioned are different in degree as the sun is more or less distant from the earth; being greatest when the earth is in its perihelion, and smallest when it is in its aphelion: for in the quarters, the nearer the moon is to the sun the greater is the addition to the earth's action upon it by the power of the sun; and, in the conjunction and opposition, the difference between the sun's action upon the earth and upon the moon is likewise so much the greater. This difference in the distance between the earth and the sun produces a further effect upon the moon's motion; causing her orbit to dilate when less remote from the sun, and become greater than when at a farther distance: For it is proved by Sir Isaac Newton, that the action of the sun by which it diminishes the earth's power over the moon in the conjunction or opposition, is about twice as great as the addition to the earth's action by the sun in the quarters; so that upon the whole, the power of the earth on the moon is diminished by the sun, and therefore is most diminished when that action is strongest: but as the earth, by its approach to the sun, has its influence lessened, the moon, being less attracted, will gradually recede from the earth; and as the earth, in its recess from the sun, recovers by degrees its former power, the orbit of the moon must again contract. Two consequences follow from hence, viz. that the moon will be more remote from the earth when the latter is nearest the sun, and also will take up a longer time in performing its revolution through the dilated orbit than through the more contracted.

These irregularities would be produced if the moon without being acted upon unequally by the sun, should describe a perfect circle about the earth, and in the plane of its motion; but though neither of these circumstances take place, yet the above-mentioned inequalities occur only with some little variation with regard to the degree of them; but some others are observed to take place from the moon's motion being performed in the manner already described: For, as the moon describes an ellipsis, having the earth in one of its foci, this curve will be subjected to various changes, neither preserving constantly the same figure nor position; and because the plane of this ellipsis is not the same with that of the earth's orbit, it thence follows, that the former will continually change; so that neither the inclination of the two planes towards each other, nor the line in which they intersect, will remain for any length of time unaltered.

381 Action of the sun causes the plane of the moon's orbit to change.

As the moon does not move in the same plane with the earth, the sun is but seldom in the plane of her orbit, viz. only when the line made by the common intersection of the two planes, if produced, will pass through the sun. Thus, let S in fig. 139. denote the sun, T the earth, ATB the plane of the earth's orbit, CDEF the moon's orbit; the part CDE being raised above, and the part CFE depressed under the former. Here the line CE, in which the two planes intersect each other, being continued, passes through the sun in S. When this happens, the action of the sun is directed in the plane of the moon's orbit, and cannot draw her out of this plane, as will evidently appear from an inspection of the figure; but in other cases the obliquity of the sun's action to the plane of the orbit will cause this plane continually to change.

Let us now suppose, in the first place, the line in which the two planes intersect each other to be perpendicular to the line which joins the earth and sun. Let T, in fig. 140, 141, 142, 143. represent the earth; S the sun; the plane of the scheme the plane of the earth's orbit, in which both the sun and earth are placed. Let AC be perpendicular to ST, which joins the earth and sun; and let the line AC be that in which the plane of the moon's orbit intersects the orbit of the earth. On the centre T describe in the plane of the earth's motion the circle ABCD; and in the plane of the moon's orbit describe the circle AECF; one half of which, AEC, will be elevated above the plane of this scheme, and the other half, AFC, as much depressed below it. Suppose then the moon to set out from the point A in fig. 127. in the direction of the plane AEC. Here she will be continually drawn out of this plane by the action of the sun; for this plane AEC, if extended, will not pass through the sun, but above it; so that the sun by drawing the moon directly toward itself, will force it continually

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continually more and more from that plane towards the plane of the earth's motion in which itself is, causing it to describe the line AKGHI, which will be convex to the plane AEC, and concave to the plane of the earth's motion. But here this power of the sun, which is said to draw the moon toward the plane of the earth's motion, must be understood principally of as much only of the sun's action upon the moon as it exceeds the action of the same upon the earth: For suppose the last-mentioned figure to be viewed by the eye placed in the plane of that scheme, and in the line CTA, on the side A, it will appear as the straight line DTB in fig. 126. and the plane AECF as another straight line FE, and the curve line AKGHI under the form of the line TKGHI. Now it is plain, that the earth and moon being both attracted by the sun, if the sun's action upon both was equally strong, the earth T, and with it the plane AECF, or the line FTE, would be carried towards the sun with as great velocity as the moon, and therefore the moon not drawn out of it by the sun's action, except only from the small obliquity of direction of this action upon the moon to that of the sun's action upon the earth, which arises from the moon being out of the plane of the earth's motion, and is not considerable: but the action of the sun upon the moon being greater than upon the earth all the time the moon is nearer to the sun than the earth is, it will be drawn from the plane AEC, or the line TE, by that excess, and made to describe the curve line AGI or TGI. But it is the custom of astronomers, instead of considering the moon as moving in such a curve line, to refer its motion continually to the plane which touches the true line wherein it moves at the point where at any time the moon is. Thus, when the moon is in the point A, its motion is considered as being in the plane AEC, in whose direction it then attempts to move; and when in the point K, fig. 144. its motion is referred to the plane which passes through the earth and touches the line AKGHI in the point K. Thus the moon, in passing from A to I, will continually change the plane of her motion in the manner we shall now more particularly explain.

Let the plane which touches the line AKI in the point K, fig. 141. intersect the plane of the earth's orbit in the line LTM. Then, because the line AKI is concave to the plane ABC, it falls wholly between that plane and the plane which touches it in K; so that the plane MKL will cut the plane AEC before it meets the plane of the earth's motion, suppose in the line YT, and the point A will fall between K and L. With a radius equal to TY or TL describe the semicircle LYM. Now, to a spectator on the earth, the moon when in A will appear to move in the circle AECF; and when in K, will appear to be moving in the semicircle LYM. The earth's motion is performed in the plane of this scheme; and to a spectator on the earth the sun will always appear to move in that plane. We may therefore refer the apparent motion of the sun to the circle ABCD described in this plane about the earth. But the points where this circle in which the sun seems to move, intersecting the circle in which the moon is seen at any time to move, are called

382 Nodes of the moon's orbit.

the nodes of the moon's orbit at that time. When the moon is seen moving in the circle AECD, the points A and C are the nodes of the orbit; when she appears in the semicircle LYM, then L and M are the nodes. It will now appear, from what has been said, that while the moon has moved from A to K, one of the nodes has been carried from A to L, and the other as much from to C to M. But the motion from A to L and from C to M is backward in regard to the motion of the moon, which is the other way from A to K, and from thence toward C. Again, the angle which the plane wherein the moon at any time appears makes with the plane of the earth's motion, is called the inclination of the moon's orbit at that time: we shall now therefore proceed to show, 383 Inclination of her orbit.
that this inclination of the orbit, when the moon is in K, is less than when she was in A; or, that the plane LYM, which touches the line of the moon's motion in K, makes a less angle with the plane of the earth's motion, or with the circle ABCD, than the plane AEC makes with the same. The semicircle LYM intersects the semicircle AEC in Y, and the arch AY is less than LY, and both together less than half a circle. But it is demonstrated by spheric geometry, that when a triangle is made as here, by three arches of circles AL, AY, and YL, the angle under YAB without the triangle is greater than the angle YLA within, if the two arches AY, YL, taken together, do not amount to a semicircle. If the two arches make a complete semicircle, the two angles will be equal; but if the two arches taken together exceed a semicircle, the inner angle YLA is greater than the other. Here then the two arches AY and LY together being less than a semicircle, the angle under ALY is less than the angle under BAE. But from the doctrine of the sphere it is also evident, that the angle under ALY is equal to that in which the plane of the circle LYKM, that is, the plane which touches the line AKGHI in K, is inclined to the plane of the earth's motion ABC; and the angle under BAE is equal to that in which the plane AEC is inclined to the same plane. Therefore the inclination of the former plane is less than that of the latter. Suppose, now, the moon to be advanced to the point G in fig. 142. and in this point to be distant from its node a quarter part of the whole circle; or, in other words, to be in the mid-way between its two nodes. In this case the nodes will have receded yet more, and the inclination of the orbit be still more diminished; for suppose the line AKGHI to be touched in the point G by a plane passing through the earth T, let the intersection of this plane with the plane of the earth's motion be the line WTO, and the line TP its intersection with the plane LKM. In this plane let the circle NGO be described with the semidiameter TP or NT cutting the other circle LKM in P. Now, the line AKGI is convex to the plane LKM which touches it in K; and therefore the plane NGO, which touches it in G, will intersect the other touching plane between G and K, that is, the point P will fall between these two points, and the plane continued to the plane of the earth's motion will pass beyond L; so that the points N and O, or the places of the nodes when the moon is in G, will be farther from A and C than L and M; that is, will have moved farther backward. Besides, the inclination of the plane NGO to the plane of the earth's motion ABC is less than the inclination of the plane LKM to the same; for here also the

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the two arches LP and NP, taken together, are less than a semicircle, each of them being less than a quadrant, as appears, because GN, the distance of the moon in G from its node N, is here supposed to be a quarter part of a circle. After the moon is passed beyond G, the case is altered; for then these arches will be greater than quarters of a circle; by which means the inclination will be again increased, though the nodes still go on to move the same way. Suppose the moon in H (fig. 143.), and that the plane which touches the line AKGI in H intersects the plane of the earth's motion in the line QTR, and the plane NGO in the line TV, and besides, that the circle QHR be described in that plane: then, for the same reason as before, the point V will fall between H and G, and the plane RVQ will pass beyond the last plane OVN, causing the points Q and K to fall farther from A and C than N and O. But the arches NV, VQ are each greater than the quarter of a circle; consequently the angle under BQV will be greater than that under BNV. Lastly, when the moon is by this attraction of the sun drawn at length into the plane of the earth's orbit, the node will have receded yet more, and the inclination be so much increased, as to become somewhat more than at first: for the line AKGHI being convex to all the planes which touch it, the part HI will wholly fall between the plane QVR and the plane ABC; so that the point I will fall between B and R; and, drawing ITW, the point W will be farther removed from A than Q. But it is evident, that the plane which passes through the earth T and touches the line AGI in the point I, will cut the plane of the earth's motion ABCD in the time ITW, and be inclined to the same in the angle under HIB; so that the node which was first in A, after having passed into L, N, and Q, comes at last in the point W, as the node which was at first in C has passed from thence successively through the points M, O, and R, to I. But the angle HIB, which is now the inclination of the orbit to the plane of the ecliptic, is manifestly not less than the angle under ECB or EAB, but rather something greater. Thus the moon, while it passes from the plane of the earth's motion in the quarter, till it comes again into the same plane, has the nodes of its orbit continually moved backward, and the inclination of it at first diminished till it comes to G in fig. 128. which is near to its conjunction with the sun, but afterwards is increased again almost by the same degrees, till upon the moon's arrival again to the plane of the earth's motion, the inclination of the orbit is restored to something more than its first magnitude, though the difference is not very great, because the points I and C are not far distant from each other.

In like manner, if the moon had departed from the quarter at C, it should have described the curve line CXW in fig. 140. between the planes AFC and ADC, which would be convex to the former planes and concave to the latter; so that here also the nodes would continually recede, and the inclination of the orbit gradually diminish more and more, till the moon arrived near its opposition to the sun in X; but from that time the inclination should again increase till it become a little greater than at first. This will easily appear by considering, that as the action of the sun upon the moon, by exceeding its action upon the earth, drew it out of the plane AEC towards the sun, while the moon passed from A to I; so during its passage from C to W, the moon being all that time farther from the sun than the earth, it will be attracted less; and the earth, together with the plane AECF, will as it were be drawn from the moon, in such a manner, that the path the moon describes shall appear from the earth as it did in the former case by the moon being drawn away.

384 Motion of the nodes explained.

Such are the changes which the nodes and inclination of the moon's orbit undergo when the nodes are in the quarters; but when the nodes by their motion, and the motion of the sun together, come to be situated between the quarter and conjunction or opposition, their motion and the change made in the inclination of the orbit are somewhat different.—Let AGH, in fig. 145. be a circle described in the plane of the earth's motion, having the earth in T for its centre, A the point opposite to the sun, and G a fourth part of the circle distant from A. Let the nodes of the moon's orbit be situated in the line BTD, and B the node falling between A, the place where the moon would be in the full, and G the place where she would be in the quarter. Suppose BEDF to be the plane in which the moon attempts to move when it proceeds from the point B: then, because the moon in B is more distant from the sun than the earth, it will be less attracted by the sun, and will not descend towards the sun so fast as the earth, consequently it will quit the plane BEDF, which is supposed to accompany the earth, and describe the line BIK convex to it, till such time as it comes to the point K, where it will be in the quarter; but from thenceforth being more attracted than the earth, the moon will change its course, and the following part of the path it describes will be concave towards the plane BED or BGD, and continue concave to the plane BGD till it crosses that plane in L just as in the preceding case. Now, to show that the nodes, while the moon is passing from B to K, will proceed forward, or move the same way with the moon, and at the same time the inclination of the orbit will increase when the moon is in the point I, let the line MIN pass through the earth T, and touch the path of the moon in I, cutting the plane of the earth's motion in the line MTN, and the line BED in TO. Because the line BIK is convex to the plane BED, which touches it in B, the plane NIM must cross the plane DEB before it meets the plane CGB; and therefore the point M will fall from G towards B; and the node of the moon's orbit being translated from B towards M is moved forward.

Again, the angle under OMG, which the plane MON makes with the plane BGC, is greater than the angle OBG, which the plane BOD makes with the same. This appears from what has been already demonstrated, because the arches BO and OM are each of them less than the quarter of a circle; and therefore, taken both together, are less than a semicircle. But further, when the moon is come to the point K in its quarter, the nodes will be advanced yet farther forward, and the inclination of the orbit also more augmented. Hitherto we have referred the moon's motion to that plane which, passing through the earth, touches the path of the moon in the point where the moon is, as we have already said that the custom of astronomers

astronomers is. But in the point K no such plane can be found: on the contrary, seeing the line of the moon's motion on one side the point K is convex to the plane BED, and on the other side concave to the same, so that no plane can pass through the points T and K, but will cut the line BKL in that point; therefore, instead of such a touching plane, we must make use of PKQ, which is equivalent, and with which the line BKL shall make a less angle than with any other plane; for this does as it were touch the line BK in the point K, since it cuts it in such a manner that no other plane can be drawn so as to pass between the line BK and the plane PKQ. But now it is evident, that the point P, or the node, is removed from M towards G, that is, has moved yet farther forward; and it is likewise as manifest, that the angle under KPG, or the inclination of the moon's orbit in the point K, is greater than the angle under IMG, for the reason already given.

After the moon has passed the quarter, her plane being concave to the plane AGCH, the nodes will recede as before till she arrives at the point L; which shows, that, considering the whole time of the moon's passing from B to L, at the end of that time the nodes shall be found to have receded, or to be placed more backward, when the moon is in L than when it was in B; for the moon takes a longer time in passing from K to L than in passing from B to K; and therefore the nodes continue to recede a longer time than they moved forwards; so that their recess must surmount their advance. In the same manner, while the moon is in its passage from K to L, the inclination of the orbit shall diminish till the moon come to the point in which it is one quarter part of a circle distant from its node, suppose in the point R; and from that time the inclination will again increase. Since, therefore, the inclination of the orbit increases while the moon is passing from B to K, and diminishes itself again only while the moon is passing from K to R, then augments again while the moon passes from B to L; it thence comes to be much more increased than diminished, and thus will be distinguishably greater when the moon comes to L than when it sets out from B. In like manner, when the moon is passing from L on the other side the plane AGCH, the node will advance forward as long as the moon is between the point L and the next quarter; but afterwards it will recede till the moon come to pass the plane AGCH again, in the point V between B and A: and because the time between the moon's passing from L to the next quarter is less than the time between that quarter and the moon's coming to the point V, the node will have receded more than it has advanced; so that the point V will be nearer to A than L is to C. So also the inclination of the orbit, when the moon is in V, will be greater than when she was in L; for this inclination increases all the time the moon is betwixt L and the next quarter, decreasing only when she is passing from this quarter to the mid-way between the two nodes, and from thence increases again during the whole passage through the other half of the way to the next node.

In this manner we see, that at every period of the moon the nodes will have receded, and thereby have approached towards a conjunction with the sun: but this will be much forwarded by the motion of the earth, or the apparent motion of the sun himself. In the last scheme the sun will appear to have moved from S towards W. Let us suppose it had appeared to have moved from S to W while the moon's node has receded from B to V; then drawing the line WTX, the arch VX will represent the distance of the line drawn between the nodes from the sun when the moon is in V; whereas the arch BA represented that distance when the moon was in B. This visible motion of the sun is much greater than that of the node; for the sun appears to revolve quite round in one year, while the node is near nineteen in making its revolution. We have also seen that when the moon was in the quadrature, the inclination of her orbit decreased till she came to the conjunction or opposition, according to the node it set out from; but that afterwards it again increased till it became at the next node rather greater than at the former. When the node is once removed from the quarter nearer to a conjunction with the sun, the inclination of the moon's orbit, when she comes into the node, is more sensibly greater than it was in the node preceding; the inclination of the orbit by this means more and more increasing till the nodes come into conjunction with the sun: at which time it has been shown that the latter has no power to change the plane of her orbit. As soon, however, as the nodes are got out of conjunction towards the other quarters, they begin to recede as before; but the inclination of the orbit in the appulse of the moon to each succeeding node is less than at the preceding, till the nodes come again into the quarters. This will appear as follows: Let A, in fig. 146. represent one of the moon's nodes placed between the point of opposition B and the quarter C. Let the plane ADE pass through the earth T, and touch the path of the moon in A. Let the line AFGH be the path of the moon in her passage from A to H, where she crosses again the plane of the earth's motion. This line will be convex towards the plane ADE, till the moon comes to G, where she is in the quarter; and after this, between G and H, the same line will be concave towards this plane. All the time this line is convex towards the plane ADE, the nodes will recede; and, on the contrary, move forward when the line is concave towards that plane. But the moon is longer in passing from A to G, and therefore the nodes go backward farther than they proceed; and therefore, on the whole, when the moon has arrived at H, the nodes will have receded, that is, the point H will fall between B and E. The inclination of the orbit will decrease till the moon is arrived at the point F in the middle between A and H. Through the passage between F and G the inclination will increase, but decrease again in the remaining part of the passage from G to H, and consequently at H must be less than at A. Similar effects, both with respect to the nodes and inclination of the orbit, will take place in the following passage of the moon on the other side of the plane ABEC from H, till it comes over that plane again in I.

Thus the inclination of the orbit is greatest when the line drawn between the moon's nodes will pass through the sun, and least when this line lies in the quarters; especially if the moon at the same time be in conjunction with the sun, or in the opposition. In the

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the first of these cases the nodes have no motion; in all others, the nodes will each month have receded: and this retrograde motion will be greatest when the nodes are in the quarters, for in that case they will have no progressive motion during the whole month; but in all other cases they at some times go forward, viz. whenever the moon is between either of the quarters and the node which is less distant from that quarter than the fourth part of a circle.

385 Irregularities arising from the moon's motion in an ellipsis.

We have now only to explain those irregularities of the lunar motion which arise from her motion in an ellipsis. From what has been already said it appears, that the earth acts on the moon in the reciprocal duplicate proportion of the distance; therefore the moon, if undisturbed by the sun, would move round the earth in a true ellipsis, and a line drawn from the earth to the sun would pass over equal spaces in equal times. We have, however, already shown, that this equality is disturbed by the sun, and likewise how the figure of the orbit is changed each month; that the moon is nearer the earth at the new and full, and more remote in the quarters than it would be without the sun. We must, however, pass by those monthly changes, and consider the effect which the sun will have in the different situations of the axis of the orbit in respect of that luminary. This action varies the force wherewith the moon is drawn towards the earth. In the quarters the force of the earth is directly increased by the sun, but diminished at the new and full; and in the intermediate places the influence of the earth is sometimes lessened, sometimes assisted, by the action of that luminary. In these intermediate places, however, between the quarters and the conjunction or opposition, the sun's action is so oblique to that of the earth on the moon, as to produce that alternate acceleration and retardation of her motion so often mentioned. But besides this effect, the power by which the moon attracts the earth towards itself, will not be at full liberty to act with the same force as if the sun acted not at all on the moon; and this effect of the sun's action, whereby it corroborates or weakens the action of the earth, is here only to be considered; and by means of this influence it comes to pass, that the power by which the moon is impelled towards the earth is not perfectly in the reciprocal duplicate proportion of the distance, and of consequence the moon will not describe a perfect ellipsis. One particular in which the lunar orbit will differ from a perfect elliptic figure, consists in the places where the motion of the moon is perpendicular to the line drawn from itself to the earth. In an ellipsis, after the moon should have set out in the direction perpendicular to this line, drawn from itself to the earth, and at its greatest distance from the earth, its motion would again become perpendicular to this line drawn between itself and the earth, and the moon be at its nearest distance from the earth, when it should have performed half its period: after having performed the other half period of its motion, it would again become perpendicular to the forementioned line, and the moon return to the place whence it set out, and have recovered again its greatest distance. But the moon in its real motion, after setting out as before, sometimes makes more than half a revolution before its motion comes again to be perpendicular to the line drawn from itself to the earth, and the moon is at its nearest distance, and then performs more than another half of an entire revolution before its motion can a second time recover its perpendicular direction to the line drawn from the moon to the earth, and the former arrive again at its greatest distance from the earth. At other times the moon will descend to her nearest distance before she has made half a revolution, and recover again its greatest distance before it has made an entire revolution. The place where the moon is at its greatest distance is called the *moon's apogeon*, and the place of her nearest distance her *perigeon*; and this change of place, where the moon comes successively to its greatest distance from the earth, is called the *motion of the apogeon*. The manner in which this motion of the apogeon is caused by the sun, comes now to be explained.

386 Apogeon and perigeon of the moon.

Sir Isaac Newton has shown, that if the moon were attracted toward the earth by a composition of two powers, one of which was reciprocally in the duplicate proportion of the distance from the earth, and the other reciprocally in the triplicate proportion of the same distance; then, though the line described by the moon would not be in reality an ellipsis, yet the moon's motion might be perfectly explained by an ellipsis whose axis should be made to move round the earth: this motion being in consequence, as astronomers express themselves, that is, the same way as the moon itself moves, if the moon be attracted by the sum of the two powers; but the axis must move in antecedence, or the contrary way, if the moon be acted upon by the difference of these forces. We have already explained what is meant by duplicate proportion, namely, that if three magnitudes, as A, B, and C, are so related that the second B bears the same proportion to the third C as the first A bears to the second B; then the proportion of the first A to the third C is the duplicate of the proportion of the first A to the second B. Now if a fourth magnitude as D be assumed, to which C shall bear the same proportion as A bears to B, and B to C; then the proportion of A to D is the triplicate of the proportion of A to B.

387 Motion in antecedence and consequence explained.

388 Triplicate proportion explained.

389 Motion of the moon's apogeon determined.

Let now T (fig. 147, 148.) denote the earth, and suppose the moon in the point A its apogeon or greatest distance from the earth, moving in the direction AF perpendicular to AB, and acted upon from the earth by two such forces as already mentioned. By that power alone, which is reciprocally in the duplicate proportion of the distance, if the moon set out with a proper degree of velocity, the ellipsis AMB may be described: but if the moon be acted upon by the sum of the forementioned powers, and her velocity in the point A be augmented in a certain proportion; or if that velocity be diminished in a certain proportion *, and the moon be acted upon by the difference of those powers; in both these cases the line AE, which shall be described by the moon, shall thus be determined. Let the point M be that into which the moon would have arrived in any given point of time, had it moved in the ellipsis AMB; draw MT and likewise CTD in such a manner that the angle ATM shall bear the same proportion to the angle under ATC as the velocity with which the ellipsis must have been described bears to the difference between this velocity and that with which the moon must set out from the point A, in order to describe the path AE. Let the angle ATC be taken towards the moon, as in fig. 133.

* See *Newton's Principia*, book i. prop. 44. corol. 2.

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if the moon be attracted by the fum of the powers; but the contrary way (as in fig. 134.) if by their difference. Then let the line AB be moved into the pofition CD, and the ellipfis AMB into the fituation CND, fo that the point M be tranflated to L; then the point L fhall fall upon the path of the moon AE. Now the angular motion of the line AT, whereby it is removed into the fituation CT, reprefents the motion of the apogeon; by the means of which the motion of the moon might be fully explained by the ellipfis AMB, if the action of the fun upon it was directed to the centre of the earth, and reciprocally in the triplicate proportion of the moon's diftance from it; but that not being fo, the motion of the apogeon will not proceed in the regular manner now defcribed. It is, however, to be obferved here, that in the firft of the two preceding cafes, where the apogeon moves forward, the whole centripetal power increafes fafter, with the decreafe of diftance, than if the entire power were reciprocally in the duplicate proportion of the diftance; becaufe one part only is already in that proportion, and the other part, which is added to this to make up the whole power, increafes fafter with the decreafe of diftance. On the other hand, when the centripetal power is the difference between thefe two bodies, it increafes lefs with the decreafe of the diftance, than if it were fimply in the reciprocal duplicate proportion of the diftance. Therefore, if we choofe to explain the moon's motion by an ellipfis, which may be done without any fenfible error, we may collect in general, that when the power by which the moon is attracted to the earth, by varying the diftance, increafes in a greater than the duplicate proportion of the diftance diminifhed, a motion in confequence muft be afcribed to the apogeon; but that when the attraction increafes in a fmaller proportion than that juft mentioned, the apogeon muft have given to it a motion in antecedence. It is then obferved by Sir Ifaac Newton, that the former of thefe cafes obtains when the moon is in the conjunction and oppofition, and the latter when fhe is in the quarters; fo that in the former the apogeon moves according to the order of the figns; in the other, the contrary way. But, as has been already mentioned, the difturbance given to the action of the earth by the fun in the conjunction and oppofition, being near twice as great as in the quarters, the apogeon will advance with a greater velocity than recede, and in the compafs of a whole revolution of the moon will be carried in confequence.

390 Inequality in the motion of the apogeon.

Sir Ifaac fhows, in the next place, that when the line AB coincides with the line that joins the fun and earth, the progreffive motion of the apogeon, when the moon is in conjunction or oppofition, exceeds the retrograde, in the quadratures, more than in any other fituation of the line AB. On the contrary, when the line AB makes right angles with that which joins the earth and fun, the retrograde motion will be more confiderable, nay, is found fo great as to exceed the progreffive; fo that in this cafe the apogeon, in the compafs of an entire revolution of the moon, is carried in antecedence. Yet from the confiderations already mentioned, the progreffive motion exceeds the other; fo that, on the whole, the motion of the apogeon is in confequence. The line AB alfo changes its fituation with that which joins the earth and fun by fuch flow degrees, that the inequalities of the motion of the apogeon, arifing from this laft confideration, are much greater than what arife from the other.

391 Occafions another inequality in the eccentricity of the moon's orbit.

This unfteady motion of the apogeon gives rife to another inequality in the motion of the moon herfelf, fo that it cannot at all times be explained by the fame ellipfis. For whenever the apogeon moves in confequence, the motion of the luminary muft be referred to an orbit more eccentric than what the moon would defcribe, if the whole power by which the moon was acted upon in its paffing from the apogeon changed according to the reciprocal duplicate proportion of its diftance from the earth, and by that means the moon did defcribe an immoveable ellipfis: and when the apogeon moves in antecedence, the moon's motion muft be referred to an orbit lefs eccentric. In the former of the two figures laft referred to, the true place of the moon L falls without the orbit AMB, to which its motion is referred: whence the orbit ALE truly defcribed by the moon, is lefs incurvated in the point A than is the orbit AMB; therefore this orbit is more oblong, and differs farther from a circle than the ellipfis would, whofe curvature in A were equal to that of the line ALB: that is, the proportion of the diftance of the earth T from the centre of the ellipfis to its axis, will be greater in AMB than in the other; but that other is the ellipfis which the moon would defcribe, if the power acting upon it in the point A were altered in the reciprocal duplicate proportion of the diftance; and confequently the moon being drawn more forcibly toward the earth, it will defcend nearer to it. On the other hand, when the apogeon recedes, the power acting on the moon increafes with the decreafe of diftance, in lefs than the duplicate proportion of the diftance; and therefore the moon is lefs impelled towards the earth, and will not defcend fo low. Now, fuppofe, in the former of thefe figures, that the apogeon A is in the fituation where it is approaching towards the conjunction or oppofition of the fun; in this cafe its progreffive motion will be more and more accelerated. Here fuppofe the moon, after having defcended from A through the orbit AE as far as F, where it is come to its neareft diftance from the earth, afcends again up the line FG. As the motion of the apogeon is here more and more accelerated, it is plain that the caufe of its motion muft alfo be on the increafe; that is, the power by which the moon is drawn to the earth, will decreafe with the increafe of the moon's diftance in her afcent from F, in a greater proportion than that wherewith it is increafed with the decreafe of diftance in the moon's defcent to it. Confequently the moon will afcend to a greater diftance than AT from whence it is defcended; therefore the proportion of the greateft diftance of the moon to the leaft is increafed. But farther, when the moon again defcends, the power will increafe yet farther with the decreafe of diftance than in the laft afcent it increafed with the augmentation of diftance. The moon therefore muft defcend nearer to the earth than it did before, and the proportion of the greateft diftance to the leaft be yet more increafed. Thus, as long as the apogeon is advancing to the conjunction or oppofition, the proportion of the greateft diftance of the moon from the earth to the leaft will continually increafe; and the elliptical orbit to which the moon's motion is referred will

will become more and more eccentric. As ſoon, however, as the apogeon is paſt the conjunction or oppoſition with the ſun, its progreſſive motion abates, and with it the proportion of the greateſt diſtance of the moon from the earth to the leaſt will alſo diminiſh: and when the apogeon becomes retrograde, the diminution of this proportion will be ſtill farther continued, until the apogeon comes into the quarter; from thence this proportion, and the eccentricity of the orbit, will increaſe again. Thus the orbit of the moon is moſt eccentric when the apogeon is in conjunction with the ſun, or in oppoſition to it, and leaſt of all when the apogeon is in the quarters. Theſe changes in the nodes, the inclination of the orbit to the plane of the earth's motion, in the apogeon and in the eccentricity, are varied like the other inequalities in the motion of the moon, by the different diſtance of the earth from the ſun being greateſt when their cauſe is greateſt: that is, when the earth is neareſt the ſun. Sir Iſaac Newton has computed the very quantity of many of the moon's inequalities. That acceleration of the moon's motion which is called the *variation*, when greateſt, removes the luminary out of the place in which it would otherwiſe be found, ſomewhat more than half a degree. If the moon, without diſturbance from the ſun, would have deſcribed a circle concentrical to the earth, his action will cauſe her approach nearer in the conjunction and oppoſition than in the quarters, nearly in the proportion of 69 to 70. It has already been mentioned, that the nodes perform their period in almoſt 19 years. This has been found by obſervation; and the computations of Sir Iſaac aſſigned to them the ſame period. The inclination of the moon's orbit, when leaſt, is an angle about one-eighteenth of that which conſtitutes a right angle; and the difference between the greateſt and leaſt inclination, is about one-eighteenth of the leaſt inclination, according to our author's computation: which is alſo agreeable to the general obſervations of aſtronomers.

392 Computation of the lunar inequalities.

There is one empirical equation of the moon's motion which the compariſon of ancient and modern eclipſes obliges the aſtronomers to employ, without being able to deduce it, like the reſt, *à priori*, from the theory of an univerſal force inverſely proportional to the ſquare of the diſtance. It has therefore been conſidered as a ſtumbling block in the Newtonian philoſophy. This is what is called *the ſecular equation of the moon's mean motion*. The mean motion is deduced from a compariſon of diſtant obſervations. The time between them, being divided by the number of intervening revolutions, gives the average time of one revolution, or the mean lunar period. When the ancient Chaldean obſervations are compared with thoſe of Hipparchus, we obtain a certain period; when thoſe of Hipparchus are compared with ſome in the 9th century, we obtain a period ſomewhat ſhorter; when the laſt are compared with thoſe of Tycho Brahé, we obtain one ſtill ſhorter; and when Brahé's are compared with thoſe of our day, we obtain the ſhorteſt period of all—and thus the moon's mean motion appears to accelerate continually; and the accelerations appear to be in the duplicate ratio of the times. The acceleration for the century which ended in 1700 is about 9 ſeconds of a degree; that is to ſay, the whole motion of the moon during the 17th century muſt be increaſed 9 ſeconds, in order to obtain its motion during the 18th; and as much muſt be taken from it, or added to the computed longitude, to obtain its motion during the 16th; and the double of this muſt be taken from the motion during the 16th, to obtain its motion during the 15th, &c. Or it will be ſufficient to calculate the moon's mean longitude for any time paſt or to come by the ſecular motion which obtains in the preſent century, and then to add to this longitude the product of 9 ſeconds, multiplied by the ſquare of the number of centuries which intervene. Thus having found the mean longitude for the year 1200, add 9 ſeconds, multiplied by 36, for ſix centuries. By this method we ſhall make our calculation agree with the moſt ancient and all intermediate obſervations. If we neglect this correction, we ſhall differ more than a degree from the Chaldean obſervation of the moon's place in the heavens.

393 The ſecular equation of the moon's mean diſtance.

The mathematicians having ſucceeded ſo completely in deducing all the obſerved inequalities of the planetary motions, from the ſingle principle, that the deflecting forces diminiſhed in the inverſe duplicate ratio of the diſtances, were fretted by this exception, the reality of which they could not conteſt. Many opinions were formed about its cauſe. Some have attempted to deduce it from the action of the planets on the moon; others have deduced it from the oblate form of the earth, and the tranſlation of the ocean by the tides; others have ſuppoſed it owing to the reſiſtance of the ether in the celeſtial ſpaces; and others have imagined that the action of the deflecting force requires time for its propagation to a diſtance: But their deductions have been proved unſatisfactory, and have by no means the preciſion and evidence that have been attained in the other queſtions of phyſical aſtronomy. At laſt M. de la Place, of the Royal Academy of Sciences at Paris, has happily ſucceeded, and deduced the ſecular equation of the moon from the Newtonian law of planetary deflection. It is produced in the following manner.

394 Deduced from the Newtonian law of planetary deflection.

Suppoſe the moon revolving round the earth, undiſturbed by any deflection toward the ſun, and that the time of her revolution is exactly aſcertained. Now let the influence of the ſun be added. This diminiſhes her tendency to the earth in oppoſition and conjunction, and increaſes it in the quadratures: but the diminutions exceed the augmentations both in quantity and duration; and the exceſs is equivalent to $\frac{1}{179}$th of her tendency to the earth. Therefore this diminiſhed tendency cannot retain the moon in the ſame orbit; ſhe muſt retire farther from the earth, and deſcribe an orbit which is leſs incurvated by $\frac{1}{179}$th part; and ſhe muſt employ a longer time in a revolution. The period therefore which we obſerve, is not that which would have obtained had the moon been influenced by the earth alone. We ſhould not have known that her natural period was increaſed, had the diſturbing influence of the ſun remained unchanged; but this varies in the inverſe triplicate ratio of the earth's diſtance from the ſun, and is therefore greater in our winter, when the earth is nearer to the ſun. This is the ſource of the annual equation, by which the lunar period in January is made to exceed that in July nearly 24 minutes. The angular velocity of the moon is diminiſhed in general $\frac{1}{179}$, and this numerical coefficient varies in the inverſe ratio of the cube

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of the earth's diſtance from the ſun. If we expand this inverſe cube of the earth's diſtance into a ſeries arranged according to the ſines and coſines of the earth's mean motion, making the earth's mean diſtance unity, we ſhall find that the ſeries contains a term equal to $\frac{2}{3}$ of the ſquare of the eccentricity of the earth's orbit. Therefore the expreſſion of the diminution of the moon's angular velocity contains a term equal to $\frac{1}{179}$ of this velocity, multiplied by $\frac{3}{2}$ of the ſquare of the earth's eccentricity; or equal to the product of the ſquare of the eccentricity, multiplied by the moon's angular velocity, and divided by 119,33 ($\frac{2}{3}$ of 179). Did this eccentricity remain conſtant, this product would alſo be conſtant, and would ſtill be confounded with the general diminution, making a conſtant part of it: but the eccentricity of the earth's orbit is known to diminiſh, and its diminution is the reſult of the univerſality of the Newtonian law of the planetary deflections. Although this diminution is exceedingly ſmall, its effect on the lunar motion becomes ſenſible by accumulation in the courſe of ages. The eccentricity diminiſhing, the diminution of the moon's angular motion muſt alſo diminiſh, that is, the angular motion muſt increaſe.

During the 18th century, the ſquare of the earth's eccentricity has diminiſhed 0,0000015325, the mean diſtance from the ſun being = 1. This has increaſed the angular motion of the moon in that time 0,00000001285. As this augmentation is gradual, we muſt multiply the angular motion during the century by the half of this quantity, in order to obtain its accumulated effect. This will be found to be 9″ very nearly, which exceeds that deduced from a moſt careful compariſon of the motion of the laſt two centuries, only by a fraction of a ſecond.

As long as the diminution of the ſquare of the eccentricity of the earth's orbit can be ſuppoſed proportional to the time, this effect will be as the ſquares of the times. When this theory is compared with obſervations, the coincidence is wonderful indeed. The effect on the moon's motion is periodical, as the change of the ſolar eccentricity is, and its period includes millions of years. Its effect on the moon's longitude will amount to ſeveral degrees before the ſecular acceleration change to a retardation.

Thoſe who are not familiar with the diſquiſitions of modern analyſis, may conceive this queſtion in the following manner.

Let the length of a lunar period be computed for the earth's diſtance from the ſun for every day of the year. Add them into one ſum, and divide this by their number, the quotient will be the mean lunar period. This will be found to be greater than the arithmetical medium between the greateſt and the leaſt. Then ſuppoſe the eccentricity of the earth's orbit to be greater, and make the ſame computation. The average period will be found ſtill greater, while the medium between the greateſt and leaſt periods will hardly differ from the former. Something very like this may be obſerved without any calculation, in a caſe very ſimilar. The angular velocity of the ſun is inverſely as the ſquare of his diſtance. Look into the ſolar tables, and the greateſt diurnal motion will be found 3673″, and the leaſt 3433″. The mean of theſe is 3553″, but the medium of the whole is 3548″. Now make a ſimilar obſervation in tables of the motion of the planet Mars, whoſe eccentricity is much greater. We ſhall find that the medium between the greateſt and leaſt exceeds the true medium of all in a much greater proportion.

It has been ſuppoſed by ſome philoſophers that the moon was originally a comet, which paſſing very near the earth, had been made to revolve round her by the force of attraction. But if we calculate ever ſo far backwards, we ſtill find the moon revolving round the earth as the planets round the ſun, which could not be the caſe if this opinion were true. Hence it follows, that neither the moon nor any of the ſatellites have ever been comets.

Sect. V. *Of Irregularities in the Satellites of Jupiter.*

The ſubſerviency of the eclipſes of Jupiter's ſatellites to geography and navigation had occaſioned their motions to be very carefully obſerved, ever ſince theſe uſes of them were firſt ſuggeſted by Galileo; and their theory is as far advanced as that of the primary planets. It has peculiar difficulties. Being very near to Jupiter, the great deviation of his figure from perfect ſphericity makes the relation between their diſtances from his centre and their gravitations toward it vaſtly complicated. But this only excited the mathematicians ſo much the more to improve their analyſis; and they ſaw, in this little ſyſtem of Jupiter and his attendants, an epitome of the ſolar ſyſtem, where the great rapidity of the motions muſt bring about in a ſhort time every variety of configuration or relative poſition, and thus give us an example of thoſe mutual diſturbances of the primary planets, which require thouſands of years for the diſcovery of their periods and limits. We have derived ſome very remarkable and uſeful pieces of information from this inveſtigation; and have been led to the diſcovery of the eternal durability of the ſolar ſyſtem, a thing which Newton greatly doubted of.

Mr Pound had obſerved long ago, that the irregularities of the three interior ſatellites were repeated in a period of 437 days; and this obſervation is found to be juſt to this day.

		Days	H.	M.
247 revolutions of the firſt occupy		437	3	44
123	ſecond	437	3	42
61	third	437	3	36
26	fourth	435	14	16

This naturally led mathematicians to examine their motions, and ſee in what manner their relative poſitions or configurations, as they are called, correſponded to this period: and it is found, that the mean longitude of the firſt ſatellite, *minus* thrice the mean longitude of the ſecond, *plus* twice the mean longitude of the third, always made 180 degrees. This requires that the mean motion of the firſt, added to twice that of the third, ſhall be equal to thrice the mean motion of the ſecond. This correſpondence of the mean motions is of itſelf a ſingular thing, and the odds againſt its probability ſeems infinitely great; and when we add to this the particular poſitions of the ſatellites in any one moment, which is neceſſary for the above conſtant relation of their longitudes, the improbability of the coincidence, as a thing quite fortuitous, becomes infinitely greater. Doubts were firſt entertained of the coincidence,

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coincidence, because it was not indeed accurate to a second. The result of the investigation is curious. When we follow out the consequences of mutual gravitation, we find, that although neither the primitive motions of projection, nor the points of the orbit from which the satellites were projected, were *precisely* such as suited these observed relations of their revolutions and their contemporaneous longitudes; yet if they differed from them only by very minute quantities, the mutual gravitations of the satellites would in time bring them into those positions, and those states of mean motion, that would induce the observed relations; and when they are once induced they will be continued for ever. There will indeed be a small equation, depending on the degree of unsuitableness of the first motions and positions; and this causes the whole system to oscillate, as it were, a little, and but a very little way on each side of this exact and permanent state. The permanency of these relations will not be destroyed by any secular equations arising from external causes; such as the action of the fourth satellite, or of the sun, or of a resisting medium; because their mutual actions will distribute this equation as it did the original error.

For a full discussion of this curious but difficult subject, we refer the reader to the dissertations of La Grange and La Place, and to the tables lately published by Delambre. These mathematicians have shown, that if the mass of Jupiter be represented by unity, that of his satellites will be represented by the following numbers.

First satellite	0.0000172011
Second satellite	0.0000237103
Third satellite	0.0000872128
Fourth satellite	0.0000544681

Sect. VI. *Of Saturn's Ring.*

395 Saturn's ring.

The most important addition (in a philosophical view) which has been made to astronomical science since the discovery of the aberration of light and the nutation of the earth's axis, is that of the rotation of Saturn's ring. The ring itself is an object quite peculiar; and when it was discovered that all the bodies which had any immediate connexion with a planet gravitated toward that planet, it became an interesting question to ascertain what was the nature of this ring? What supports this immense arch of heavy matter without its resting on the planet? What maintains it in perpetual concentricity with the body of Saturn, and keeps its surface in one invariable position?

The theory of universal gravitation tells us what things are possible in the solar system; and our conjectures about the nature of this ring must always be regulated by the circumstance of its gravitation to the planet. Philosophers had at first supposed it to be a luminous atmosphere, thrown out into that form by the great centrifugal force arising from a rotation: but its well-defined edge, and, in particular, its being two very narrow rings, extremely near each other, yet perfectly separate, rendered this opinion of its constitution more improbable.

396 Discovery of Dr Herschel relating to it.

Dr Herschel's discovery of brighter spots on its surface, and that those spots were permanent during the whole time of his observation, seem to make it more probable that the parts of the ring have a solid connexion. Mr Herschel has discovered, by the help of those spots, that the ring turns round its axis, and that this axis is also the axis of Saturn's rotation. The time of rotation is 10h. $32\frac{1}{4}'$. But the other circumstances are not narrated with the precision sufficient for an accurate comparison with the theory of gravity. He informs us, that the radii of the four edges of the ring are 590, 751, 774, 830, of a certain scale, and that the angle subtended by the ring at the mean distance from the earth is $46\frac{2}{3}''$. Therefore its elongation is $23\frac{1}{3}''$. The elongation of the second Cassinian satellite is 56″, and its revolution is 2d. 17h. 44′. This should give, by the third law of Kepler, 17h. 10′ for the revolution of the outer edge of the ring, or rather of an atom of that edge, in order that it may maintain itself in equilibrio. The same calculation applied to the outer edge of the inner ring gives about 13h. 36′; and we obtain 11h. 16′ for the inner edge of this ring. Such varieties are inconsistent with the permanent appearance of a spot. We may suppose the ring to be a luminous fluid or vapour, each particle of which maintains its situation by the law of planetary revolution. In such a state, it would consist of concentric strata, revolving more slowly as they were more remote from the planet, like the concentric strata of a vortex, and therefore having a relative motion incompatible with the permanency of any spot. Besides, the rotation observed by Herschel is too rapid even for the innermost part of the ring. We think therefore that it consists of cohering matter, and of considerable tenacity, at least equal to that of a very clammy fluid, such as melted glass.

We can tell the figure which a fluid ring must have, so that it may maintain its form by the mutual gravitation of its particles to each other, and their gravitation to the planet. Suppose it cut by a meridian. It may be in equilibrio if the section is an ellipse, of which the longer axis is directed to the centre of the planet, and very small in comparison with its distance from the centre of the planet, and having the revolution of its middle round Saturn, such as agree with the Keplerean law. These circumstances are not very consistent with the dimensions of Saturn's inner ring. The distance between the middle of its breadth and the centre of Saturn is 670, and its breadth is 161′, nearly one-fourth of the distance from the centre of Saturn. De la Place says, that the revolution of the inner ring observed by Herschel is very nearly that required by Kepler's law: but we cannot see the grounds of this assertion. The above comparison with the second Cassinian satellite shows the contrary. The elongation of that satellite is taken from Bradley's observations, as is also its periodic time. A ring of detached particles revolving in 10h. $32\frac{1}{4}'$ must be of much smaller diameter than even the inner edge of Saturn's ring. Indeed the quantity of matter in it might be such as to increase the gravitation considerably; but this would be seen by its disturbing the seventh and sixth satellites, which are exceedingly near it. We cannot help thinking therefore that it consists of matter which has very considerable tenacity. An equatorial zone of matter, tenacious like melted glass, and whirled briskly round, might be thrown off, and, retaining its great velocity, would stretch out while whirling, enlarging in diameter and diminishing in thickness or breadth, or both, till the centrifugal force was balanced by the united force of gravity 397 Its probable consistency

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gravity and tenacity. We find that the equilibrium will not be ſenſibly diſturbed by conſiderable deviations, ſuch as equal breadth, or even want of flatneſs. Such inequalities appear on the ring at that time of its diſparition, when its edge is turned to the ſun or to us. The appearances of its different ſides are then conſiderably different.

Such a ring or rings muſt have an oſcillatory motion round the centre of Saturn, in conſequence of their mutual action, and the action of the ſun, and their own irregularities: but there will be a certain poſition which they have a tendency to maintain, and to which they will be brought back, after deviating from it, by the ellipticity of Saturn, which is very great. The ſun will occaſion a nutation of Saturn's axis and a preceſſion of his equinoxes, and this will drag along with it both the rings and the neighbouring ſatellites.

The atmoſphere which ſurrounds a whirling planet cannot have all its parts circulating according to the third law of Kepler. The mutual attrition of the planet, and of the different ſtrata, ariſing from their different velocities, muſt accelerate the ſlowly moving ſtrata, and retard the rapid, till all acquire a velocity proportional to their diſtance from the axis of rotation; and this will be ſuch that the momentum of rotation of the planet and its atmoſphere remains always the ſame. It will ſwell out at the equator, and ſink at the poles, till the centrifugal force at the equator balances the height of a ſuperficial particle. The greateſt ratio which the equatorial diameter can acquire to the polar axis is that of four to three, unleſs a coheſive force keeps the particles united, ſo that it conſtitutes a liquid, and not an elaſtic fluid like air; and an elaſtic fluid cannot form an atmoſphere bounded in its dimenſions, unleſs there be a certain rarity which takes away all elaſticity. If the equator ſwells beyond the dimenſion which makes the gravitation balance the centrifugal force, it muſt immediately diſſipate.

If we ſuppoſe that the atmoſphere has extended to this limit, and then condenſes by cold, or any chemical or other cauſe different from gravity, its rotation neceſſarily augments, preferring its former momentum,
398 [Saturn's ring] and origin.
and the limit will approach the axis; becauſe a greater velocity produces a greater centrifugal force, and requires a greater gravitation to balance it. Such an atmoſphere may therefore deſert, in ſucceſſion, zones of its own matter in the plane of its equator, and *leave* them revolving in the form of rings. It is not unlikely that the rings of Saturn may have been furniſhed in this very way; and the zones, having acquired a common velocity in their different ſtrata, will preſerve it; and they are ſuſceptible of irregularities ariſing from local cauſes at the time of their ſeparation, which may afford permanent ſpots.

Sect. VII. *Of the Atmoſpheres of the Planets.*

By *atmoſphere* is meant a rare, tranſparent, compreſſible, and elaſtic fluid ſurrounding a body. It is ſuppoſed that all the heavenly bodies poſſeſs atmoſpheres. The atmoſphere of the earth is familiar to all its inhabitants. Obſervation points out the atmoſpheres of the ſun and of Jupiter; but that of the other planets is ſcarcely perceptible.

The atmoſphere becomes rarer in proportion to its diſtance from the body to which it belongs, in conſequence of its elaſticity, which, cauſes it to dilate the more the leſs it is compreſſed. If its moſt remote parts were ſtill poſſeſſed of elaſticity, they would ſeparate indefinitely, and the whole would be ſcattered through ſpace. To prevent this effect it is neceſſary that the elaſticity ſhould diminiſh at a greater rate than the compreſſing force, and that when it reaches a certain degree of rarity its elaſticity ſhould vaniſh altogether.

All the atmoſpheric ſtrata muſt gradually acquire the ſame rotatory motion with the bodies to which they belong in conſequence of the continual friction to which their different parts muſt be ſubjected, which will gradually accelerate or retard the different parts till a common motion is produced. In all theſe changes, and indeed in all thoſe which the atmoſphere undergoes, the ſum of the products of the particles of the body and of its atmoſphere multiplied by the areas deſcribed round their common centres of gravity by their radii vectors projected in the plane of the equator continue always the ſame, the times being the ſame. If we ſuppoſe then, by any cauſe whatever, the height of the atmoſphere is diminiſhed, and a portion of it condenſes on the ſurface of the planet; the conſequence will be, that the rotatory motion of the planet and of its atmoſphere will be accelerated. For the radii vectors of the areas deſcribed by the particles of the primitive atmoſphere becoming ſhorter, the ſum of the products of all theſe particles by the correſponding areas cannot remain the ſame unleſs the rotatory motion augment.

At the upper ſurface of the atmoſphere the fluid is retained only by its weight. Its figure is ſuch that the direction reſulting from the combination of the centrifugal forces and the attracting forces is perpendicular to it. It is flattened at the poles, and more convex at the equator. But this flattening has its limits. When a maximum the axis of the poles is to that at the equator as 2 to 3.

At the equator the atmoſphere can only extend to the place where the centrifugal force and gravitation exactly balance each other; for if it paſs that limit, it will be diſſipated altogether. Hence it follows that the ſolar atmoſphere does not extend as far as Mercury; conſequently it is not the cauſe of the zodiacal light which appears to extend even beyond the earth's orbit.

The place where the centrifugal force and gravitation balance each other is ſo much the nearer a body the more rapid its rotatory motion is. If we ſuppoſe the atmoſphere to extend to that limit, and then to condenſe by cooling, &c. at the ſurface of the planet the rotatory motion will increaſe in rapidity in proportion to this condenſation, and the limit of the height of the atmoſphere will conſtantly approach the planet. The atmoſphere would of courſe abandon ſucceſſively zones of fluid in the plane of the equator, which would continue to circulate round the body. We have ſhown in the laſt ſection that Saturn's ring may owe its origin to this cauſe.

399 Probable reaſon why we ſee no atmoſphere about the moon.

We may add alſo, that the action of another body may conſiderably change the conſtitution of this atmoſphere. Thus, ſuppoſing that the moon had originally an atmoſphere, the limit will be that diſtance from the moon where the centrifugal force, ariſing from the moon's rotation, added to the gravitation

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tion to the earth, balances the gravitation to the moon. If the moon be $\frac{1}{39}$th of the earth, this limit will be about $\frac{1}{9}$th of the moon's diſtance from the earth. If at this diſtance the elaſticity of the atmoſphere is not annihilated by its rarefaction, it will be all taken off by the earth, and accumulate round it. This may be the reaſon why we ſee no atmoſphere about the moon.

Sect. VII. *Of the Tides.*

400 Cauſe of the tides diſcovered by Kepler.

The cauſe of the tides was diſcovered by Kepler, who, in his *Introduction to the Phyſics of the Heavens*, thus explains it: "The orb of the attracting power which is in the moon, is extended as far as the earth; and draws the waters under the torrid zone, acting upon places where it is vertical, inſenſibly on confined ſeas and bays, but ſenſibly on the ocean, whoſe beds are large, and where the waters have the liberty of reciprocation, that is, of riſing and falling." And in the 70th page of his *Lunar Aſtronomy*—"But the cauſe of the tides of the ſea appears to be the bodies of the ſun and moon drawing the waters of the ſea." This hint being given, the immortal Sir Iſaac Newton improved it, and wrote ſo amply on the ſubject, as to make the theory of the tides in a manner quite his own, by diſcovering the cauſe of their riſing on the ſide of the earth oppoſite to the moon. For Kepler believed that the preſence of the moon occaſioned an impulſe which cauſed another in her abſence.

It has been already obſerved, that the power of gravity diminiſhes as the ſquare of the diſtance increaſes; and therefore the waters at Z on the ſide of the earth
Fig. 149. ABCDEFGH next the moon M, are more attracted than the central parts of the earth O by the moon, and the central parts are more attracted by her than the waters on the oppoſite ſide of the earth at *n*: and therefore the diſtance between the earth's centre and the waters on its ſurface under and oppoſite to the moon will be increaſed. For, let there be three bodies at H, O, and D: if they are all equally attracted by the body M, they will all move equally faſt towards it, their mutual diſtances from each other continuing the ſame. If the attraction of M is unequal, then that body which is moſt ſtrongly attracted will move faſteſt, and this will increaſe its diſtance from the other body. Therefore, by the law of gravitation, M will attract H more ſtrongly than it does O, by which the diſtance between H and O will be increaſed; and a ſpectator on O will perceive H riſing higher toward Z. In like manner, O being more ſtrongly attracted than D, it will move farther towards M than D does: conſequently, the diſtance between O and D will be increaſed; and a ſpectator on O, not perceiving his own motion, will ſee D receding farther from him towards *n*; all effects and appearances being the ſame, whether D recedes from O, or O from D.

Suppoſe now there is a number of bodies, as A, B, C, D, E, F, G, H, placed round O, ſo as to form a flexible or fluid ring: then, as the whole is attracted towards M, the parts at H and D will have their diſtance from O increaſed; whilſt the parts at B and F being nearly at the ſame diſtance from M as O is, theſe parts will not recede from one another; but rather, by the oblique attraction of M, they will approach nearer to O. Hence the fluid ring will form itſelf into an ellipſe ZIBL*n*KFNZ, whoſe larger axis *n*OZ produced will paſs through M, and its ſhorter axis BOF will terminate in B and F. Let the ring be filled with fluid particles, ſo as to form a ſphere round O; then, as the whole moves towards M, the fluid ſphere being lengthened at Z and *n*, will aſſume an oblong or oval form. If M is the moon, O the earth's centre, ABCDEFGH the ſea covering the earth's ſurface, it is evident, by the above reaſoning, that whilſt the earth by its gravity falls towards the moon, the water directly below her at B will ſwell and riſe gradually towards her; alſo the water at D will recede from the centre [ſtrictly ſpeaking, the centre recedes from D], and riſe on the oppoſite ſide of the earth; whilſt the water at B and F is depreſſed, and falls below the former level. Hence as the earth turns round its axis from the moon to the moon again in $24\frac{3}{4}$ hours, there will be two tides of flood and two of ebb in that time, as we find by experience.

401 Why the tides are high at full moon.

As this explanation of the ebbing and flowing of the ſea is deduced from the earth's conſtantly falling towards the moon by the power of gravity, ſome may find a difficulty in conceiving how this is poſſible, when the moon is full, or in oppoſition to the ſun; ſince the earth revolves about the ſun, and muſt continually fall towards it, and therefore cannot fall contrary ways at the ſame time: or if the earth is conſtantly falling towards the moon, they muſt come together at laſt. To remove this difficulty, let it be conſidered, that it is not the centre of the earth that deſcribes the annual orbit round the ſun, but the (E) common centre of gravity of the earth and moon together; and that whilſt the earth is moving round the ſun, it alſo deſcribes a circle round that centre of gravity; going as many times round it in one revolution about the ſun as there are lunations or courſes of the moon round the earth in a year: and therefore the earth is conſtantly falling towards the moon from a tangent to the circle it deſcribes round the ſaid common centre of gravity. Let M be Fig. 150.
the moon, TW part of the moon's orbit, and C the centre of gravity of the earth and moon; whilſt the moon goes round her orbit, the centre of the earth deſcribes the circle *dge* round C, to which circle *gak* is a tangent; and therefore when the moon has gone from M to a little paſt W, the earth has moved from *g* to *e*; and in that time has fallen towards the moon, from the tangent at *a* to *e*: and ſo on, round the whole circle.

The ſun's influence in raiſing the tides is but ſmall in

(E) This centre is as much nearer the earth's centre than the moon's as the earth is heavier, or contains a greater quantity of matter than the moon, namely, about 40 times. If both bodies were ſuſpended on it, they would hang *in equilibrio*. So that dividing 240,000 miles, the moon's diſtance from the earth's centre, by 40, the exceſs of the earth's weight above the moon's, the quotient will be 6000 miles, which is the diſtance of the common centre of gravity of the earth and moon from the earth's centre.

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in comparison of the moon's; for though the earth's diameter bears a considerable proportion to its distance from the moon, it is next to nothing when compared to its distance from the sun. And therefore the difference of the sun's attraction on the sides of the earth under and opposite to him, is much less than the difference of the moon's attraction on the sides of the earth under and opposite to her; and therefore the moon must raise the tides much higher than they can be raised by the sun.

402 Influence of the sun in raising tides.

403 Why they are not highest when the moon is in the meridian.

On this theory, the tides ought to be highest directly under and opposite to the moon; that is, when the moon is due north and south. But we find, that in open seas, where the water flows freely, the moon M is generally past the north and south meridian, as at *p*, when it is high water at Z and at *n*. The reason is obvious: for though the moon's attraction was to cease altogether when she was past the meridian, yet the motion of ascent communicated to the water before that time would make it continue to rise for some time after; much more must it do so when the attraction is only diminished; as a little impulse given to a moving ball will cause it still to move farther than otherwise it could have done; and as experience shows that the day is hotter about three in the afternoon, than when the sun is on the meridian, because of the increase made to the heat already imparted.

The tides answer not always to the same distance of the moon from the meridian at the same places; but are variously affected by the action of the sun, which brings them on sooner when the moon is in her first and third quarters, and keeps them back later when she is in her second and fourth: because, in the former case, the tide raised by the sun alone would be earlier than the tide raised by the moon: and, in the latter case, later.

The moon goes round the earth in an elliptic orbit; and therefore, in every lunar month, she approaches nearer to the earth than her mean distance, and recedes farther from it. When she is nearest, she attracts strongest, and so raises the tides most: the contrary happens when she is farthest, because of her weaker attraction. When both luminaries are in the equator, and the moon in perigee, or at her least distance from the earth, she raises the tides highest of all, especially at her conjunction and opposition; both because the equatorial parts have the greatest centrifugal force from their describing the largest circle, and from the concurring actions of the sun and moon. At the change, the attractive forces of the sun and moon being united, they diminish the gravity of the waters under the moon, and their gravity on the opposite side is diminished by means of a greater centrifugal force. At the full, whilst the moon raises the tide under and opposite to her, the sun, acting in the same line, raises the tide under and opposite to him; whence their conjoint effect is the same as at the change; and, in both cases, occasion what we call the *Spring Tides*. But at the quarters the sun's action on the waters at O and H diminishes the effect of the moon's action on the waters at Z and N; so that they rise a little under and opposite to the sun at O and H, and fall as much under and opposite to the moon at Z and N; making what we call the *Neap Tides*, because the sun and moon then act cross-wise to each other. But these tides happen not till some time after; because in this, as in other cases, the actions do not produce the greatest effect when they are at the strongest, but some time afterward.

The sun being nearer the earth in winter than in summer, is of course nearer to it in February and October than in March and September; and therefore the greatest tides happen not till some time after the autumnal equinox, and return a little before the vernal.

The sea, being thus put in motion, would continue to ebb and flow for several times, even though the sun and moon were annihilated, or their influence should cease; as, if a bason of water were agitated, the water would continue to move for some time after the bason was left to stand still; or like a pendulum, which, having been put in motion by the hand, continues to make several vibrations without any new impulse.

When the moon is in the equator, the tides are equally high in both parts of the lunar day, or time of the moon's revolving from the meridian to the meridian again, which is 24 hours 50 minutes. But as the moon declines from the equator towards either pole, the tides are alternately higher and lower at places having north or south latitude. For one of the highest elevations, which is that under the moon, follows her towards the pole to which she is nearest, and the other declines towards the opposite pole; each elevation describing parallels as far distant from the equator, on opposite sides, as the moon declines from it to either side; and consequently the parallels described by these elevations of the water are twice as many degrees from one another as the moon is from the equator; increasing their distance as the moon increases her declination, till it be at the greatest, when the said parallels are, at a mean state, 47 degrees from one another: and on that day, the tides are most unequal in their heights. As the moon returns towards the equator, the parallels described by the opposite elevations approach towards each other, until the moon comes to the equator, and then they coincide. As the moon declines towards the opposite pole, at equal distances, each elevation describes the same parallel in the other part of the lunar day, which its opposite elevation described before. Whilst the moon has north declination, the greatest tides in the northern hemisphere are when she is above the horizon; and the reverse whilst her declination is south. Let NESQ be the earth, NSC its axis, EQ the equator, T ♋ the tropic of Cancer, *t* ♑ the tropic of Capricorn, *a b* the arctic circle, *c d* the antarctic, N the north pole, S the south pole, M the moon, F and G the two eminences of water, whose lowest parts are, at *a* and *d*, at N and S, and at *b* and *c*, always 90 degrees from the highest. Now, when the moon is in her greatest north declination at M, the highest elevation G under her is on the tropic of Cancer T ♋, and the opposite elevation F on the tropic of Capricorn *t* ♑; and these two elevations describe the tropics by the earth's diurnal rotation. All places in the northern hemisphere ENQ have the highest tides when they come into the position *b* ♋ Q, under the moon; and the lowest tides when the earth's diurnal rotation carries them into the position *a* TE, on the side opposite to the moon; the reverse happens at the same time in the southern hemisphere ESQ, as is evident to sight. Fig. 151, 152, 153.

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The axis of the tides *a* C *d* had now its poles *a* and *d* (being always 90 degrees from the highest elevations) in the arctic and antarctic circles; and therefore it is plain, that at these circles there is but one tide of flood, and one of ebb, in the lunar day. For, when the point *a* revolves half round to *b* in 12 lunar hours, it has a tide of flood; but when it comes to the same point *a* again in 12 hours more, it has the lowest ebb. In seven days afterward, the moon M comes to the equinoctial circle, and is over the equator EQ, when both elevations describe the equator; and in both hemispheres, at equal distances from the equator, the tides are equally high in both parts of the lunar day. The whole phenomena being reversed, when the moon has south declination, to what they were when her declination was north, require no farther description.

In the three last-mentioned figures, the earth is orthographically projected on the plane of the meridian; but in order to describe a particular phenomenon, we now project it on the plane of the ecliptic. Let
Fig. 151. HZON be the earth and sea, FED the equator, T the tropic of Cancer, C the arctic circle, P the north pole, and the curves, 1, 2, 3, &c. 24 meridians or hour circles, intersecting each other in the poles: AGM is the moon's orbit, S the sun, M the moon, Z the water elevated under the moon, and N the opposite equal elevation. As the lowest parts of the water are always 90 degrees from the highest, when the moon is in either of the tropics (as at M), the elevation Z is on the tropic of Capricorn, and the opposite elevation N on the tropic of Cancer; the low-water circle HCO touches the polar circles at C; and the high-water circle ETP 6 goes over the poles at P, and divides every parallel of latitude into two equal segments. In this case, the tides upon every parallel are alternately higher and lower; but they return in equal times: the point T, for example, on the tropic of Cancer, (where the depth of the tide is represented by the breadth of the dark shade) has the shallower tide of flood at T than when it revolves half round from thence to 6, according to the order of the numeral figures; but it revolves as soon from 6 to T as it did from T to 6. When the moon is in the equinoctial, the elevations Z and N are transferred to the equator at O and H, and the high and low-water circles are got into each other's former places; in which case the tides return in unequal times, but are equally high in both parts of the lunar day; for a place at 1 (under D) revolving as formerly, goes sooner from 1 to 11 (under F) than from 11 to 1, because the parallel it describes is cut into unequal segments by the high-water circle HCO: but the points 1 and 11 being equidistant from the pole of the tides at C, which is directly under the pole of the moon's orbit MGA, the elevations are equally high in both parts of the day.

404
Tides turn on the axis of the moon's orbit.

And thus it appears, that as the tides are governed by the moon, they must turn on the axis on the moon's orbit, which is inclined $23\frac{1}{2}$ degrees to the earth's axis at a mean state: and therefore the poles of the tides must be so many degrees from the poles of the earth, or in opposite points of the polar circles, going round these circles in every lunar day. It is true, that according to fig. 153. when the moon is vertical to the equator ECQ, the poles of the tides seem to fall in with the poles of the world N and S: but when we consider that FGH is under the moon's orbit, it will appear, that when the moon is over H, in the tropic of Capricorn, the north pole of the tides (which can be no more than 90 degrees from under the moon) must be at C in the arctic circle, not at P the north pole of the earth; and as the moon ascends from H to G in her orbit, the north pole of the tides must shift from *c* to *a* in the arctic circle, and the south poles as much in the antarctic.

It is not to be doubted, but that the earth's quick rotation brings the poles of the tides nearer to the poles of the world than they would be if the earth were at rest, and the moon revolved about it only once a month; for otherwise the tides would be more unequal in their heights and times of their returns, than we find they are. But how near the earth's rotation may bring the poles of its axis and those of the tides together, or how far the preceding tides may affect those which follow, so as to make them keep up nearly to the same heights and times of ebbing and flowing, is a problem more fit to be solved by observation than by theory.

Those who have opportunity to make observations, and choose to satisfy themselves whether the tides are really affected in the above manner by the different positions of the moon, especially as to the unequal times of their return, may take this general rule for knowing when they ought to be so affected. When the earth's axis inclines to the moon, the northern tides, if not retarded in their passage through shoals and channels, nor affected by the winds, ought to be greatest when the moon is above the horizon, least when she is below it, and quite the reverse when the earth's axis declines from her; but in both cases, at equal intervals of time. When the earth's axis inclines sidewise to the moon, both tides are equally high, but they happen at unequal intervals of time. In every lunation the earth's axis inclines once to the moon, once from her, and twice sidewise to her, as it does to the sun every year; because the moon goes round the ecliptic every month, and the sun but once in a year. In summer, the earth's axis inclines towards the moon when new; and therefore the day-tides in the north ought to be highest, and night-tides lowest, about the change: at the full, the reverse. At the quarters, they ought to be equally high, but unequal in their returns: because the earth's axis then inclines sidewise to the moon. In winter, the phenomena are the same at full moon as in summer at new. In autumn the earth's axis inclines sidewise to the moon when new and full; therefore the tides ought to be equally high and uneven in their returns at these times. At the first quarter, the tides of flood should be least when the moon is above the horizon, greatest when she is below it; and the reverse at her third quarter. In spring, the phenomena of the first quarter answer to those of the third quarter in autumn; and *vice versa*. The nearer any tide is to either of the seasons, the more the tides partake of the phenomena of these seasons; and in the middle between any two of them the tides are at a mean state between those of both.

In open seas, the tides rise but to very small heights in proportion to what they do in wide-mouthed rivers, opening in the direction of the stream of tide. For in channels growing narrower gradually, the water is accumulated

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cumulated by the oppofition of the contracting bank; like a gentle wind, little felt on an open plain, but ftrong and brifk in a ftreet; efpecially if the wider end of the ftreet be next the plain, and in the way of the wind.

405 Irregularities of tides accounted for.

The tides are fo retarded in their paffage through different fhoals and channels, and otherwife fo varioufly affected by ftriking againft capes and headlands, that to different places they happen at all diftances of the moon from the meridian, confequently at all hours of the lunar day. The tide propagated by the moon in the German ocean, when fhe is three hours paft the meridian, takes 12 hours to come from thence to London bridge, where it arrives by the time that a new tide is raifed in the ocean. And therefore, when the moon has north declination, and we fhould expect the tide at London to be greateft when the moon is above the horizon, we find it is leaft; and the contrary when fhe has fouth declination. At feveral places it is high water three hours before the moon comes to the meridian; but that tide which the moon pufhes as it were before her, is only the tide oppofite to that which was raifed by her when fhe was nine hours paft the oppofite meridian.

There are no tides in lakes, becaufe they are generally fo fmall, that when the moon is vertical fhe attracts every part of them alike, and therefore by rendering all the water equally light, no part of it can be raifed higher than another. The Mediterranean and Baltic feas have very fmall elevations, becaufe the inlets by which they communicate with the ocean are fo narrow, that they cannot, in fo fhort a time, receive or difcharge enough to raife or fink their furfaces fenfibly.

For a more complete difcuffion of this important fubject, we refer the reader to the article TIDE.

SECT. IX. *Of the Preceffion of the Equinoxes, and the Nutation of the Earth's Axis.*

406 Preceffion of the equinoctial points, &c.

IT now remains to confider the preceffion of the equinoctial points, with its equations, arifing from the nutation of the earth's axis as a phyfical phenomenon, and to endeavour to account for it upon thofe mechanical principles which have fo happily explained all the other phenomena of the celeftial motions.

407 Obfervations of Newton and others on this fubject.

This did not efcape the penetrating eye of Sir Ifaac Newton; and he quickly found it be a confequence, and the moft beautiful proof, of the univerfal gravitation of all matter to all matter; and there is no part of his immortal work where his fagacity and fertility of refource fhine more confpicuoufly than in this inveftigation. It muft be acknowledged, however, that Newton's inveftigation is only a fhrewd guefs, founded on affumptions, of which it would be extremely difficult to demonftrate either the truth or falfity, and which required the genius of a Newton to pick out in fuch a complication of abftrufe circumftances. The fubject has occupied the attention of the firft mathematicians of Europe fince his time; and is ftill confidered as the moft curious and difficult of all mechanical problems. The moft elaborate and accurate differtations on the preceffion of the equinoxes are thofe of Sylvabella and Walmefly, in the Philofophical Tranfactions, publifhed about the year 1754; that of Thomas Simpfon, publifhed in his Mifcellaneous Tracts; that of Father Frifius, in the Memoirs of the Berlin Academy, and afterwards, with great improvements, in his Cofmographia; that of Euler in the Memoirs of Berlin; that of D'Alembert in a feparate differtation; and that of De la Grange on the Libration of the Moon, which obtained the prize in the Academy of Paris in 1769. We think the differtation of Father Frifius the moft perfpicuous of them all, being conducted in the method of geometrical analyfis; whereas moft of the others proceed in the fluxionary and fymbolic method, which is frequently deficient in diftinct notions of the quantities under confideration, and therefore does not give us the fame perfpicuous conviction of the truth of the refults. In a work like ours, it is impoffible to do juftice to the problem, without entering into a detail which would be thought extremely difproportioned to the fubject by the generality of our readers. Yet thofe who have the neceffary preparation of mathematical knowledge, and wifh to underftand the fubject fully, will find enough here to give them a very diftinct notion of it; and in the article ROTATION, they will find the fundamental theorems, which will enable them to carry on the inveftigation. We fhall firft give a fhort fketch of Newton's inveftigation, which is of the moft palpable and popular kind, and is highly valuable, not only for its ingenuity, but alfo becaufe it will give our unlearned readers diftinct and fatisfactory conceptions of the chief circumftances of the whole phenomena.

Let S (fig. 154.) be the fun, E the earth, and M the moon, moving in the orbit NMCDn, which cuts the plane of the ecliptic in the line of the nodes Nn, and has one half raifed above it, as reprefented in the figure, the other half being hid below the ecliptic. Suppofe this orbit folded down; it will coincide with the ecliptic in the circle N$mcdn$. Let EX reprefent the axis of this orbit, perpendicular to its plane, and therefore inclined to the ecliptic. Since the moon gravitates to the fun in the direction MS, which is all above the ecliptic, it is plain that this gravitation has a tendency to draw the moon towards the ecliptic. Suppofe this force to be fuch that it would draw the moon down from M to t in the time that fhe would have moved from M to t, in the tangent to her orbit. By the combination of thefe motions, the moon will defert her orbit, and defcribe the line Mr, which makes the diagonal of the parallelogram; and if no farther action of the fun be fuppofed, fhe will defcribe another orbit M$\delta n'$, lying between the orbit MCDn and the ecliptic, and fhe will come to the ecliptic, and pafs through it in a point n', nearer to M than n is, which was the former place of her defcending node. By this change of orbit, the line EX will no longer be perpendicular to it; but there will be another line Ex, which will now be perpendicular to the new orbit. Alfo the moon, moving from M to r, does not move as if fhe had come from the afcending node N, but from a point N lying beyond it; and the line of the nodes of the orbit in this new pofition is N' n'. Alfo the angle MN'm is lefs than the angle MNm. 408 Sketch of Newton's inveftigation of it.

Thus the nodes fhift their places in a direction oppofite to that of her motion, or move to the weftward; the axis of the orbit changes its pofition, and the orbit itfelf changes its inclination to the ecliptic. Thefe momentary changes are different in different parts of the orbit, according to the pofition of the line of the nodes.

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nodes. Sometimes the inclination of the orbit is increased, and sometimes the nodes move to the eastward. But, in general, the inclination increases from the time that the nodes are in the line of syzigee, till they get into quadrature, after which it diminishes till the nodes are again in syzigee. The nodes advance only while they are in the octants after the quadratures, and while the moon passes from quadrature to the node, and they recede in all other situations. Therefore the recess exceeds the advance in every revolution of the moon round the earth, and, on the whole, they recede.

What has been said of one moon, would be true of each of a continued ring of moons surrounding the earth, and they would thus compose a flexible ring, which would never be flat, but waved, according to the difference (both in kind and degree) of the disturbing forces acting on its different parts. But suppose these moons to cohere, and to form a rigid and flat ring, nothing would remain in this ring but the excess of the contrary tendencies of its different parts. Its axis would be perpendicular to its plane, and its position in any moment will be the mean position of all the axes of the orbits of each part of the flexible ring; therefore the nodes of this rigid ring will continually recede, except when the plane of the ring passes through the sun, that is, when the nodes are in syzigee; and (says Newton) the motion of these nodes will be the same with the mean motion of the nodes of the orbit of one moon. The inclination of this ring to the ecliptic will be equal to the mean inclination of the moon's orbit during any one revolution which has the same situation of the nodes. It will therefore be least of all when the nodes are in quadrature, and will increase till they are in syzigee, and then diminish till they are again in quadrature.

Suppose this ring to contract in dimensions, the disturbing forces will diminish in the same proportion, and in this proportion will all their effects diminish. Suppose its motion of revolution to accelerate, or the time of a revolution to diminish; the linear effects of the disturbing forces being as the squares of the times of their action, and their angular effects as the times, those errors must diminish also on this account; and we can compute what those errors will be for any diameter of the ring, and for any period of its revolution. We can tell, therefore, what would be the motion of the nodes, the change of inclination, and deviation of the axis, of a ring which would touch the surface of the earth, and revolved in 24 hours; nay, we can tell what these motions would be, should this ring adhere to the earth. They must be much less than if the ring were detached; for the disturbing forces of the ring must drag along with it the whole globe of the earth. The quantity of motion which the disturbing forces would have produced in the ring alone, will now (says Newton) be produced in the whole mass; and therefore the velocity must be as much less as the quantity of matter is greater: But still all this can be computed.

Now there is such a ring on the earth: for the earth is not a sphere, but an elliptical spheroid. Sir Isaac Newton therefore engaged in a computation of the effects of the disturbing force, and has exhibited a most beautiful example of mathematical investigation. He first asserts, that the earth *must* be an elliptical spheroid, whose polar axis is to its equatorial diameter as 229 to 230. Then he demonstrates, that if the sine of the inclination of the equator be called π, and if t be the number of days (sidereal) in a year, the annual motion of a detached ring will be $360^\circ \times \frac{3\sqrt{1-\pi^2}}{4t}$. He then shows that the effect of the disturbing force on this ring is to its effect on the matter of the same ring, distributed in the form of an elliptical stratum (but still detached) as 5 to 2; therefore the motion of the nodes will be $360^\circ \times \frac{3\sqrt{1-\pi^2}}{10t}$, or 16′ 16″ 24‴ annually. He then proceeds to show, that the quantity of motion in the sphere is to that in an equatorial ring revolving in the same time, as the matter in the sphere to the matter in the ring, and as three times the square of a quadrantal arch to two squares of a diameter, jointly: Then he shows, that the quantity of matter in the terrestrial sphere is to that in the protuberant matter of the spheroid, as 52900 to 461 (supposing all homogeneous). From these premises it follows, that the motion of 16′ 16″ 24‴, must be diminished in the ratio of 10717 to 100, which reduces it to 9″ 07‴ annually. And this (he says) is the precession of the equinoxes, occasioned by the action of the sun; and the rest of the 50⅓″, which is the observed precession, is owing to the action of the moon, nearly five times greater than that of the sun. This appeared a great difficulty: for the phenomena of the tides show that it *cannot* much exceed twice the sun's force.

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His determination of the form and dimensions of the earth demonstrated by M'Laurin.

Nothing can exceed the ingenuity of this process. Justly does his celebrated and candid commentator, Daniel Bernouilli, say (in his Dissertation on the Tides, which shared the prize of the French Academy with M'Laurin and Euler), that Newton saw through a veil what others could hardly discover with a microscope in the light of the meridian sun. His determination of the form and dimensions of the earth, which is the foundation of the whole process, is not offered as any thing better than a probable guess, *in re difficillima*; and it has been since demonstrated with geometrical rigour by M'Laurin.

His next principle, that the motion of the nodes of the rigid ring is equal to the mean motion of the nodes of the moon, has been most critically discussed by the first mathematicians, as a thing which could neither be proved nor refuted. Frisius has at least shown it to be a mistake, and that the motion of the nodes of the ring is double the mean motion of the nodes of a single moon; and that Newton's own principles should have produced a precession of 18¼ seconds annually, which removes the difficulty formerly mentioned.

His third assumption, that the quantity of motion of the ring must be shared with the included sphere, was acquiesced in by all his commentators, till D'Alembert and Euler, in 1749, showed that it was not the quantity of motion round an axis of rotation which remained the same, but the quantity of momentum or rotatory effort. The quantity of motion is the product of every particle by its velocity; that is, by its distance from the axis; while its momentum, or power of producing rotation, is as the square of that distance, and is to be had by taking the sum of each particle multiplied by the square of its distance from the axis. Since the earth

earth differs ſo little from a perfect ſphere, this makes no ſenſible difference in the reſult. It will increaſe Newton's preceſſion about three-fourths of a ſecond.

410 Examination of the phenomenon of preceſſion on mechanical principles.

We proceed now to the examination of this phenomenon upon the fundamental principles of mechanics.

Becauſe the mutual gravitation of the particles of matter in the ſolar ſyſtem is in the inverſe ratio of the ſquares of the diſtance, it follows, that the gravitations of the different parts of the earth to the ſun or to the moon are unequal. The nearer particles gravitate more than thoſe that are more remote.

Let PQ *p* E (fig. 155.), be a meridional ſection of the terreſtrial ſphere, and PO *p q* the ſection of the inſcribed ſphere. Let CS be a line in the plane of the ecliptic paſſing through the ſun, ſo that the angle ECS is the ſun's declination. Let NCM be a plane paſſing through the centre of the earth at right angles to the plane of the meridian PQ *p* E; NCM will therefore be the plane of illumination.

In conſequence of the unequal gravitation of the matter of the earth to the ſun, every particle, ſuch as B, is acted on by a diſturbing force parallel to CS, and proportional to BD, the diſtance of the particle from the plane of illumination; and this force is to the gravitation of the central particle to the ſun, as three times BD is to CS, the diſtance of the earth from the ſun.

Let AB *a* be a plane paſſing through the particle B, parallel to the plane EQ of the equator. This ſection of the earth will be a circle, of which A *a* is a diameter, and Q *q* will be the diameter of its ſection with the inſcribed ſphere. Theſe will be two concentric circles, and the ring by which the ſection of the ſpheroid exceeds the ſection of the ſphere will have AQ for its breadth; P*p* is the axis of figure.

Let EC be repreſented by the ſymbol	a
OC or PC	b
EO their difference, $=\frac{a^2-b^2}{a+b}$	d
CL	x
QL	$\sqrt{d^2-x^2}$
The periphery of a circle to radius 1	π
The diſturbing force at the diſtance 1 from the plane NCM	f
The ſine of declination ECS	m
The coſine of ECS	n

It is evident, that with reſpect to the inſcribed ſphere, the diſturbing forces are completely compenſated, for every particle has a correſponding particle in the adjoining quadrant, which is acted on by an equal and oppoſite force. But this is not the caſe with the protuberant matter which makes up the ſpheroid. The ſegments NS *s n* and MT *t m* are more acted on than the ſegments NT *t n* and MS *s m*; and thus there is produced a tendency to a converſion of the whole earth, round an axis paſſing through the centre C, perpendicular to the plane PQ*p* E. We ſhall diſtinguiſh this motion from all others to which the ſpheroid may be ſubject, by the name Libration. The axis of this libration is always perpendicular to that diameter of the equator over which the ſun is, or to that meridian in which he is.

Prob. I. To determine the momentum of libration correſponding to any poſition of the earth reſpecting the ſun, that is, to determine the accumulated energy of the diſturbing forces on all the protuberant matter of the ſpheroid.

Let B and *b* be two particles in the ring formed by the revolution of AQ, and ſo ſituated that they are at equal diſtances from the plane NM: but on oppoſite ſides of it. Draw BD, *bd*, perpendicular to NM, and FLG perpendicular to LT.

Then, becauſe the momentum, or power of producing rotation, is as the force and as the diſtance of its line of direction from the axis of rotation, jointly, the combined momentum of the particles B and *b*, will be $f.BD.DC-f.bd.dc$, (for the particles B and *b*, are urged in contrary directions). But the momentum of B is $f.BF.DC+f.FD.DC$, and that of *b* is $f.b.G.dC-f.dG.dC$; and the combined momentum is $f.BF.Dd-f.FD.\overline{DC+dC},=2f.BF.LF-2f.LT.TC$.

Becauſe *m* and *n* are the ſine and coſine of the angle ECS or LCT, we have $LT=m.CL$, and $CT=n.CL$, and $LF=m.BL$, and $BF=n.BL$. This gives the momentum $=2fmn\,\overline{BL^2-CL^2}$.

The breadth AQ of the protuberant ring being very ſmall, we may ſuppoſe, without any ſenſible error, that all the matter of the line AQ is collected in the point Q; and, in like manner, that the matter of the whole ring is collected in the circumference of its inner circle, and that B and *b* now repreſent, not ſingle particles, but the collected matter of lines ſuch as AQ, which terminate at B and *b*. The combined momentum of two ſuch lines will therefore be $2mnf.AQ.\overline{BL^2-CL^2}$.

Let the circumference of each parallel of latitude be divided into a great number of indefinitely ſmall and equal parts. The number of ſuch parts in the circumference, of which Q *q* is the diameter will be $\pi\cdot QL$. To each pair of theſe there belongs a momentum $2mnf\cdot AQ\cdot\overline{BL^2-CL^2}$. The ſum of all the ſquares of BL, which can be taken round the circle, is one half of as many ſquares of the radius CL: for BL is the ſine of an arch, and the ſum of its ſquare and the ſquare of its correſponding coſine is equal to the ſquare of the radius. Therefore the ſum of all the ſquares of the ſines, together with the ſum of all the ſquares of the coſines, is equal to the ſum of the ſame number of ſquares of the radius; and the ſum of the ſquares of the ſines is equal to the ſum of the ſquares of the correſponding coſines: therefore the ſum of the ſquares of the radius is double of either ſum. Therefore $\int \pi\cdot QL\cdot BL^2=\frac{1}{2}\pi\cdot QL.QL^2$. In like manner the ſum of the number $\pi\cdot QL$ of CL^2s will be $=\pi\cdot QL.CL^2$. Theſe ſums, taken for the ſemicircle, are $\frac{1}{4}\pi\cdot QL\cdot QL^2$, and $\frac{1}{2}\pi\cdot QL\cdot CL^2$, or $\pi\cdot QL\cdot\frac{1}{4}QL^2$. and $\pi\cdot QL\cdot\frac{1}{2}CL^2$: therefore the momentum of the whole ring will be $2mnf\cdot AQ\cdot QL.\pi\cdot(\frac{1}{4}QL-\frac{1}{2}CL^2)$: for the momentum of the ring is the combined momenta of a number of pairs, and this number is $\frac{1}{2}\pi\cdot QL$.

By the ellipſe we have $OC:QL=EO:AQ$, and $AQ=QL\frac{EO}{OC},=QL\frac{d}{b}$; therefore the momentum of the ring is $2mnf\frac{d}{b}QL^2\pi\,(\frac{1}{4}QL^2-\frac{1}{2}CL^2),=mnf\frac{d}{b}QL^2\pi\,(\frac{1}{2}QL^2-CL^2)$: but $QL^2=b^2-x^2$; therefore $\frac{1}{2}QL^2$

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$\frac{1}{2}QL^2-CL^2=\frac{1}{2}b^2-\frac{1}{2}x^2-x^2, =\frac{1}{2}b^2-\frac{3}{2}x^2, =\frac{b^2-3x^2}{2}$; therefore the momentum of the ring is $mnf\frac{d}{b}\Pi(b^2-x^2)\left(\frac{b^2-3x^2}{2}\right)=mnf\frac{d}{b}\Pi\left(\frac{b^4-4b^2x^2+3x^4}{2}\right), =mnf\frac{d}{2b}\Pi(b^4-4b^2x^2+3x^4)$. If we now suppose another parallel extremely near to A a, as represented by the dotted line, the distance L l between them being $\dot{x}$, we shall have the fluxion of the momentum of the spheroid $mnf\frac{d}{2b}\Pi(b^4\dot{x}-4b^2x^2\dot{x}+3x^4\dot{x})$, of which the fluent is $mnf\frac{d}{2b}\Pi\left(b^4x-4b^2\frac{x^3}{3}+\frac{3x^5}{5}\right)$. This expresses the momentum of the zone EA a Q, contained between the equator and the parallel of latitude A a. Now let x become $=b$, and we shall obtain the momentum of the hemispheroid $=mnf\frac{d}{2b}\Pi(b^5-\frac{4}{3}b^5+\frac{3}{5}b^5)$, and that of the spheroid $=mnf\frac{d}{b}\Pi(b^5-\frac{4}{3}b^5+\frac{3}{5}b^5)=\frac{4}{15}mnfd\Pi b^4$.

This formula does not express any motion, but only a pressure tending to produce motion, and particularly tending to produce a libration by its action on the cohering matter of the earth, which is affected as a number of levers. It is similar to the common mechanical formula $w.d$, where w means a weight, and d its distance from the fulcrum of the lever.

It is worthy of remark, that the momentum of this protuberant matter is just $\frac{1}{5}$ of what it would be if it were all collected at the point O of the equator: for the matter in the spheroid is to that in the inscribed sphere as a^2 to b^2, and the contents of the inscribed sphere is $\frac{2}{3}\Pi b^3$. Therefore $a^2 : a^2-b^2=\frac{2}{3}\Pi b^3 : \frac{2}{3}\Pi b^3\frac{a^2-b^2}{a^2}$, which is the quantity of protuberant matter. We may, without sensible error, suppose $\frac{a^2-b^2}{a}=2d$; then the protuberant matter will be $\frac{4}{3}\Pi b^2d$. If all this were placed at O, the momentum would be $\frac{4}{3}\Pi db^2f\cdot OH\cdot HC, =\frac{4}{3}mnfdb^4$, because $OH\cdot HC=mnb^2$; now $\frac{4}{5}$ is 5 times $\frac{4}{15}$.

Also, because the sum of all the rectangles OH·HC round the equator is half of as many squares of OC, it follows that the momentum of the protuberant matter placed in a ring round the equator of the sphere, or spheroid, is one half of what it would be if collected in the point G or E; whence it follows that the momentum of the protuberant matter in its natural place is two-fifths of what it would be if it were disposed in an equatorial ring. It was in this manner that Sir Isaac Newton was enabled to compare the effect of the sun's action on the protuberant matter of the earth, with his effect on a rigid ring of moons. The preceding investigation of the momentum is nearly the same with his, and appears to us greatly preferable in point of perspicuity to the fluxionary solutions given by later authors. These indeed have the appearance of greater accuracy, because they do not suppose all the protuberant matter to be condensed on the surface of the inscribed sphere: nor were we under the necessity of doing this; only it would have led to very complicated expressions had we supposed the matter in each line AQ collected in its centre of oscillation or gyration. We made a compensation for the error introduced by this, which may amount to $\frac{1}{113}$ of the whole, and should not be neglected, by taking d as equal to $\frac{a^2-b^2}{2a}$ instead of $\frac{a^2-b^2}{a+b}$. The consequence is, that our formula is the same with that of the later authors.

Thus far Sir Isaac Newton proceeded with mathematical rigour; but in the application he made two assumptions, or, as he calls them hypotheses, which have been found to be unwarranted. The first was, that when the ring of protuberant matter is connected with the inscribed sphere, and subjected to the action of the disturbing force, the same quantity of motion is produced in the whole mass as in the ring alone. The second was, that the motion of the nodes of a rigid ring of moons is the same with the mean motion of the nodes of a solitary moon. But we are now able to demonstrate, that it is not the quantity of motion, but of momentum, which remains the same, and that the nodes of a rigid ring move twice as fast as those of a single particle. We proceed therefore to,

Effects of the libratory momentum of the earth's protuberant matter.

PROB. II. To determine the deviation of the axis, and the retrograde motion of the nodes which result from this libratory momentum of the earth's protuberant matter. 411

But here we must refer our readers to some fundamental propositions of rotatory motions which are demonstrated in the article ROTATION.

If a rigid body is turning round an axis A, passing through its centre of gravity with the angular velocity a, and receives an impulse which alone would cause it to turn round an axis B, also passing through its centre of gravity, with the angular velocity b, the body will now turn round a third axis C, passing through its centre of gravity, and lying in the plane of the axis A and B, and the sine of the inclination of this third axis to the axis A will be to the sine of the inclination to the axis B as the velocity b to the velocity a.

When a rigid body is made to turn round any axis by the action of an external force, the quantity of momentum produced (that is, the sum of the products of every particle by its velocity and by its distance from the axis) is equal to the momentum or similar product of the moving force or forces.

If an oblate spheroid, whose equatorial diameter is a and polar diameter b, be made to librate round an equatorial diameter, and the velocity of that point of the equator which is farthest from the axis of libration be v, the momentum of the spheroid is $\frac{4}{15}\Pi a^2b^2v$.

The two last are to be found in every elementary book of mechanics.

Let AN an (fig. 156.) be the plane of the earth's equator, cutting the ecliptic CNK n in the line of the nodes or equinoctial points N n. Let OAS be the section of the earth by a meridian passing through the sun, so that the line OCS is in the ecliptic, and CA is an arch of an hour-circle or meridian, measuring the sun's declination. The sun not being in the plane of the equator, there is, by prop. 1. a force tending to produce a libration round an axis ZO z at right angles to the diameter A a of that meridian in which the sun is situated, and

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and the momentum of all the difturbing forces is $\frac{4}{14} m n f d \Pi b^4$. The product of any force by the moment $\dot{t}$ of its action expreffes the momentary increment of velocity; therefore the momentary velocity, or the velocity of libration granted in the time $\dot{t}$ is $\frac{4}{15} m n f d \Pi b^4 \dot{t}$. This is the abfolute velocity of a point at the diftance 1 from the axis, or it is the fpace which would be uniformly defcribed in the moment $\dot{t}$, with the velocity which the point has acquired at the end of that moment. It is double the fpace actually defcribed by the libration during that moment; becaufe this has been an uniformly accelerated motion, in confequence of the continued and uniform action of the momentum during this time. This muft be carefully attended to, and the neglect of it has occafioned very faulty folutions of this problem.

Let v be the velocity produced in the point A, the moft remote from the axis of libration. The momentum excited or produced in the fpheroid is $\frac{4}{15} \Pi a^2 b^2 v$ (as above), and this muft be equal to the momentum of the moving force, or to $\frac{4}{15} m n f d \Pi b^4 \dot{t}$; therefore we obtain $v = \frac{\frac{4}{15} m n f d \Pi b^4 \dot{t}}{\frac{4}{15} \Pi a^2 b}$, that is, $v = m n f d \dot{t} \frac{b^2}{a^2}$ or very nearly $m n f d \dot{t}$, becaufe $\frac{b^2}{a^2} = 1$ very nearly. Alfo, becaufe the product of the velocity and tmie gives the fpace uniformly defcribed in that time, the fpace defcribed by A in its libration round Z z is $m n f d \dot{t}^2$, and the angular velocity is $\frac{m n f d \dot{t}}{a}$.

Let $\dot{r}$ be the momentary angle of diurnal rotation. The arch A r, defcribed by the point A of the equator in this moment $\dot{t}$ will therefore be $a \dot{r}$, that is, $a \times \dot{r}$, and the velocity of the point A is $\frac{a\dot{r}}{\dot{t}}$, and the angular velocity of rotation is $\frac{\dot{r}}{\dot{t}}$.

Here then is a body (fig. 157.) turning round an axis OP, perpendicular to the plane of the equator zoz, and therefore fituated in the plane ZP z; and it turns round this axis with the angular velocity $\frac{\dot{r}}{\dot{t}}$. It has received an impulfe, by which alone it would librate round the axis Z z, with the angular velocity $\frac{m n f d \dot{t}}{a}$. It will therefore turn round neither axis, but round a third axis OP′, paffing through O, and lying in the plane ZP z, in which the other two are fituated, and the fine P′Π of its inclination to the axis of libration Z z will be to the fine P′p of its inclination to the axis OP of rotation as $\frac{\dot{r}}{\dot{t}}$ to $\frac{m n f d \dot{t}}{a}$.

Now A, in fig. 156. is the fummit of the equator both of libration and rotation: $m n f d \dot{t}^2$ is the fpace defcribed by its libration in the time $\dot{t}$; and $a \dot{r}$ is the fpace or arch A r (fig. 156.) defcribed in the fame time by its rotation: therefore, taking A r to A c (perpendicular to the plane of the equator of rotation, and lying in the equator of libration), as $a \dot{r}$ to $m n f d \dot{t}^2$, and completing the parallelogram A $r m c$, A m will be the compound motion of A, and $a \dot{r} : m n d f \dot{t}^2 = 1 : \frac{m n f d \dot{t}^2}{a \dot{r}}$, which will be the tangent of the angle m A r, or of the change of pofition of the equator. But the axes of rotation are perpendicular to their equator; and therefore the angle of deviation $\dot{w}$ is equal to this angle r A m. This appears from fig. 5.; for Π P′ : P′p = O′p : P′p, = OP : tan. POP; and it is evident that $a \dot{r} : m n f d \dot{t}^2 = \frac{\dot{r}}{\dot{t}} : m n f d \frac{\dot{t}}{a}$, as is required by the compofition of rotations.

In confequence of this change of pofition, the plane of the equator no longer cuts the plane of the ecliptic in the line N n. The plane of the new equator cuts the former equator in the line AO, and the part AN of the former equator lies between the ecliptic and the new equator AN′, while the part An of the former equator is above the new one An′; therefore the new node N′, from which the point A was moving, is removed to the weftward, or farther from A; and the new node n′, to which A is approaching, is alfo moved weftward, or nearer to A; and this happens in every pofition of A. The nodes therefore or equinoctial points, continually fhift to the weftward, or in a contrary direction to the rotation of the earth; and the axis of rotation always deviates to the eaft fide of the meridian which paffes through the fun.

This account of the motions is extremely different from what a perfon fhould naturally expect. If the earth were placed in the fummer folftice, with refpect to us who inhabit its northern hemifphere, and had no rotation round its axis, the equator would begin to approach the ecliptic, and the axis would become more upright; and this would go on with a motion continually accelerating, till the equator coincided with the ecliptic. It would not ftop here, but go as far on the other fide, till its motion were extinguifhed by the oppofing forces; and it would return to its former pofition, and again begin to approach the ecliptic, playing up and down like the arm of a balance. On this account this motion is very properly termed *libration*: but this very flow libration, compounded with the incomparably fwifter motion of diurnal rotation, produces a third motion extremely different from both. At firft the north pole of the earth inclines forward toward the fun; after a long courfe of years it will incline to the left hand, as viewed from the fun, and be much more inclined to the ecliptic, and the plane of the equator will pafs through the fun. The fouth pole will come into view, and the north pole will begin to decline from the fun; and this will go on (the inclination of the equator diminifhing all the while) till, after a courfe of years, the north pole will be turned quite away from the fun, and the inclination of the equator will be reftored to its original quantity. After this the phenomena will have another period fimilar to the former, but the axis will now deviate to the right hand. And thus, although both the earth and fun fhould not move from their places, the inhabitants of the earth would have a complete fucceffion of the feafons accomplifhed in a period of many centuries. This would be prettily illuftrated by an iron ring poifed very nicely on a cap like the card of of a mariner's compass, having its centre of gravity coinciding with the point of the cap, so that it may whirl round in any position. As this is extremely difficult to execute, the cap may be pierced a little deeper, which will cause the ring to maintain a horizontal position with a very small force. When the ring is whirling very steadily, and pretty briskly, in the direction of the hours of a watch-dial, hold a strong magnet above the middle of the nearer semicircle (above the 6 hour point) at the distance of three or four inches. We shall immediately observe the ring rise from the 9 hour point, and sink at the 3 hour point, and gradually acquire a motion of precession and nutation, such as has been described.

If the earth be now put in motion round the sun, or the sun round the earth, motions of libration and deviation will still obtain, and the succession of their different phases, if we may so call them, will be perfectly analogous to the above statement. But the quantity of deviation, and change of inclination, will now be prodigiously diminished, because the rapid change of the sun's position quickly diminishes the disturbing forces, annihilates them by bringing the sun into the plane of the equator, and brings opposite forces into action.

We see in general that the deviation of the axis is always at right angles to the plane passing through the sun, and that the axis, instead of being raised from the ecliptic, or brought nearer to it, as the libration would occasion, deviates sidewise; and the equator, instead of being raised or depressed round its east and west points, is twisted sidewise round the north and south points; or at least things have this appearance: but we must now attend to this circumstance more minutely.

The composition of rotation shows us that this change of the axis of diurnal rotation is by no means a translation of the former axis (which we may suppose to be the axis of figure) into a new position, in which it again becomes the axis of diurnal motion; nor does the equator of figure, that is, the most prominent section of the terrestrial spheroid, change its position, and in this new position continue to be the equator of rotation. This was indeed supposed by Sir Isaac Newton; and this supposition naturally resulted from the train of reasoning which he adopted. It was strictly true of a single moon, or of the imaginary orbit attached to it; and therefore Newton supposed that the whole earth did in this manner deviate from its former position, still, however, turning round its axis of figure. In this he has been followed by Walmesly, Simpson, and most of his commentators. D'Alembert was the first who entertained any suspicion that this might not be certain; and both he and Euler at last showed that the new axis of rotation was really a new line in the body of the earth, and that its axis and equator of figure did not remain the axis and equator of rotation. They ascertained the position of the real axis by means of a most intricate analysis, which obscured the connexion of the different positions of the axis with each other, and gave us only a kind of momentary information. Father Frisius turned his thoughts to this problem, and fortunately discovered the composition of rotations as a general principle of mechanical philosophy. Few things of this kind have escaped the penetrating eyes of Sir Isaac Newton. Even *this* principle had been glanced at by him. He affirms it in express terms with respect to a body that is perfectly spherical (cor. 22. prop. 66. B. I.) But it was reserved for Frisius to demonstrate it to be true of bodies of any figure, and thus to enrich mechanical science with a principle which gives simple and elegant solutions of the most difficult problems.

But here a very formidable objection naturally offers itself. If the axis of the diurnal motion of the heavens is not the axis of the earth's spheroidal figure, but an imaginary line in it, round which even the axis of figure must revolve; and if this axis of diurnal rotation has so greatly changed its position, that it now points at a star at least 12 degrees distant from the pole observed by Timochares, how comes it that the equator has the very same situation on the surface of the earth that it had in ancient times? No sensible change has been observed in the latitudes of places.

The answer is very simple and satisfactory: Suppose that in 12 hours the axis of rotation has changed from the position PR (fig. 158.) to pr, so that the north pole, instead of being at P, which we may suppose to be a particular mountain, is now at p. In this 12 hours the mountain P, by its rotation round $p\,r$ has acquired the position π. At the end of the next 12 hours, the axis of rotation has got the position $\pi\varrho$, and the axis of figure has got the position $p\,r$, and the mountain P is now at p. Thus, on the noon of the following day, the axis of figure PR is in the situation which the real axis of rotation occupied at the intervening midnight. This goes on continually, and the axis of figure follows the position of the axis of rotation, and is never further removed from it than the deviation of 12 hours, which does not exceed $\frac{1}{100}$th part of one second, a quantity altogether imperceptible. Therefore the axis of figure will always sensibly coincide with the axis of rotation, and no change can be produced in the latitudes of places on the surface of the earth.

We have hitherto considered this problem in the most general manner; let us now apply the knowledge we have gotten of the deviation of the axis or of the momentary action of the disturbing force to the explanation of the phenomena; that is, let us see what precession and what nutation will be accumulated after any given time of action. 412 Application of this reasoning to nutation and precession.

For this purpose we must ascertain the precise deviation which the disturbing forces are competent to produce. This we can do by comparing the momentum of libration with the gravitation of the earth to the sun, and this with the force which would retain a body on the equator while the earth turns round its axis.

The gravitation of the earth to the sun is in the proportion of the sun's quantity of matter M directly, and to the square of the distance A inversely, and may therefore be expressed by the symbol $\frac{M}{A^2}$. The disturbing force at the distance 1 from the place of illumination is to the gravitation of the earth's centre to the sun as 3 to A, (A being measured on the same scale which measures the distance from the plane of illumination). Therefore $\frac{3M}{A^3}$ will be the disturbing force f of our formula.

Let p be the centrifugal force of a particle at the distance 1 from the axis of rotation; and let t and T be the times of rotation and of annual revolution, viz.

 sidereal

ſidereal day and year. Then $p:\frac{M}{A^2}=\frac{1}{t^2}:\frac{A}{T^2}$. Hence we derive $\frac{3M}{A^3}=3p\frac{t^2}{T^2}$. But ſince $\dot{r}$ was the angular velocity of rotation, and conſequently $1\times\dot{r}$ the ſpace deſcribed, and $\frac{1\times\dot{r}}{\dot{t}}$ the velocity; and ſince the centrifugal force is as the ſquare of the velocity divided by the radius, (this being the meaſure of the generated velocity, which is the proper meaſure of any accelerating force), we have $p=\frac{1^2\times\dot{r}^2}{1^2\times\dot{t}^2},=\frac{\dot{r}^2}{\dot{t}^2}$, and $f=\frac{3\dot{r}^2}{\dot{t}^2}\times\frac{t^2}{T^2}$. Now the formula $fmnd\frac{\dot{t}^2}{a}$ expreſſed the ſine of the angle. This being extremely ſmall, the ſine may be conſidered as equal to the arc which meaſures the angle. Now, ſubſtitute for it the value now found, viz. $\frac{3\dot{r}^2}{\dot{t}^2}\times\frac{\dot{t}^2}{T^2}$, and we obtain the angle of deviation $\dot{w}=\dot{r}\frac{3t^2}{T^2}mn\frac{d}{a}$, and this is the ſimpleſt form in which it can appear. But it is convenient, for other reaſons, to expreſs it a little differently: d is nearly equal to $\frac{a^2-b^2}{2a^2}$ therefore $\dot{w}=\dot{r}\times\frac{3t^2}{2T^2}mn\frac{a^2-b^2}{a^2}$, and this is the form in which we ſhall now employ it.

The ſmall angle $\dot{r}\frac{3t^2}{2T^2}mn\frac{a^2-b^2}{a^2}$ is the angle in which the new equator cuts the former one. It is different at different times, as appears from the variable part mn, the product of the ſine and coſine of the ſun's declination. It will be a maximum when the declination is in the ſolſtice, for mn increaſes all the way to 45°, and the declination never exceeds $23\frac{1}{2}$. It increaſes, therefore from the equinox to the ſolſtice, and then diminiſhes.

Let ESL (fig. 159.) be the ecliptic, EAC the equator, BAD the new poſition which it acquires by the momentary action of the ſun, cutting the former in the angle $BAE=\dot{r}\frac{3t^2}{2T^2}mn\frac{a^2-b^2}{a^2}$. Let S be the ſun's place in the ecliptic, and AS the ſun's declination, the meridian AS being perpendicular to the equator. Let $\frac{a^2-b^2}{a^2}$ be k. The angle BAE is then $=\dot{r}\frac{3t^2}{2T^2}kmn$. In the ſpherical triangle BAE we have ſin. B : ſin. AE= ſin. A : ſin. BE, or =A : BE, becauſe very ſmall angles and arches are as their ſines. Therefore BE, which is the momentary preceſſion of the equinoctial point E, is equal to $A\frac{\text{ſin. AE}}{\text{ſin. B}},=\dot{r}\times\frac{3t^2}{2T^2}kmn\frac{\text{ſin. R. aſcenſ.}}{\text{ſin. obl. ecl.}}$

413 Various modes of application. The equator EAC, by taking the poſition BAD, recedes from the ecliptic in the colure of the ſolſtices CL, and CD is the change of obliquity or the nutation. For let CL be the ſolſtitial colure of BAD, and cl the ſolſtitial colure of EAC. Then we have ſin. B : ſin. E = ſin. LD : ſin. lc; and therefore the difference of the arches LD and lc will be the meaſure of the difference of the angles B and E. But when BE is indefinitely ſmall, CD may be taken for the difference of LD and lc, they being ultimately in the ratio of equality. Therefore CD meaſures the change of the obliquity of the ecliptic, or the nutation of the axis with reſpect to the ecliptic.

The real deviation of the axis is the ſame with the change in the poſition of the equator, Pp being the meaſure of the angle EAB. But this not being always made in a plane perpendicular to the ecliptic, the change of obliquity generally differs from the change in the poſition of the axis. Thus, when the ſun is in the ſolſtice, the momentary change of the poſition of the equator is the greateſt poſſible; but being made at right angles to the plane in which the obliquity of the ecliptic is computed, it makes no change whatever in the obliquity, but the greateſt poſſible change in the preceſſion.

In order to find CD the change of obliquity, obſerve that in the triangle CAD, R : ſin. AC, or R : coſ. AE=ſin. A : ſin. CD, =A : CD (becauſe A and CD are exceedingly ſmall). Therefore the change of obliquity (which is the thing commonly meant by nutation) CD=A×coſ. AE, $=\dot{r}\frac{3t^2}{2T^2}kmn$, coſ. AE $=\dot{r}\frac{3t^2}{2T^2}k\times$ ſin. declin. ×coſ. declin. ×coſ. R. aſcenſ.

But it is more convenient for the purpoſes of aſtronomical computation to make uſe of the ſun's longitude SE. Therefore make

The ſun's longitude ES		$=z$
Sine of ſun's long.		$=x$
Coſine	$\sqrt{1-x^2}$	$=y$
Sine obliq. eclipt.	$23\frac{1}{2}$	$=p$
Coſine obliq.		$=q$

In the ſpherical triangle EAS, right-angled at A (becauſe AS is the ſun's declination perpendicular to the equator), we have R : ſin. ES=ſin. E : ſin. AS, and ſin. AS=px. Alſo R : coſ. AS=coſ. AE : coſ. ES, and coſ. ES or y=coſ. AS×coſ. AE. Therefore pxy=ſin. AS coſ. AS×coſ. AE, $=mn\times$coſ. AE. Therefore the momentary nutation $CD=\dot{r}\times\frac{3t^2}{2T^2}kpxy$.

We muſt recollect that this angle is a certain fraction of the momentary diurnal rotation. It is more convenient to conſider it as a fraction of the ſun's annual motion, that ſo we may directly compare his motion on the ecliptic with the preceſſion and nutation correſponding to his ſituation in the heavens. This change is eaſily made, by augmenting the fraction in the ratio of the ſun's angular motion to the motion of rotation, or multiplying the fraction by $\frac{T}{t}$; therefore the momentary nutation will be $\dot{r}\frac{3t}{2T}kpxy$. In this value $\frac{3tkp}{2T}$ is a conſtant quantity, and the momentary nutation is proportional to xy, or to the product of the ſine and coſine of the ſun's longitude, or to the ſine of twice the ſun's longitude; for xy is equal to half the ſine of twice z.

If therefore we multiply this fraction by the ſun's momentary angular motion, which we may ſuppoſe with abundant accuracy, proportional to $\dot{z}$, we obtain the fluxion of the nutation, the fluent of which will expreſs

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preſs the whole nutation while the ſun deſcribes the arch z of the ecliptic, beginning at the vernal equinox. Therefore, in place of y put $\sqrt{1-x^2}$, and in place of $\dot{z}$ put $\frac{\dot{x}}{\sqrt{1-x^2}}$, and we have the fluxion of the nutation for the moment when the ſun's longitude is z, and the fluent will be the whole nutation. The fluxion reſulting from this proceſs is $\frac{3tkp}{2T}x\dot{x}$, of which the fluent is $\frac{3tkp}{4T}x^2$. This is the whole change produced on the obliquity of the ecliptic while the ſun moves along the arch z ecliptic, reckoned from the vernal equinox. When this arch is 90°, x is 1. and therefore $\frac{3tkp}{4T}$ is the nutation produced while the ſun moves from the equinox to the ſolſtice.

414 The real and momentary change greateſt at the ſolſtices, and at the equinoxes nothing.

The momentary change of the axis and plane of the equator (which is the meaſure of the changing force) is $\frac{3tk}{2T}mn$.

The momentary change of the obliquity of the ecliptic is $\frac{3tkp}{2T}x\dot{x}$.

The whole change of obliquity is $\frac{3tkp}{4T}x^2$.

Hence we ſee that the force and the real momentary change of poſition are greateſt at the ſolſtices, and diminiſh to nothing at the equinoxes.

The momentary change of obliquity is greateſt at the octants, being proportional to $x\dot{x}$ or to xy.

The whole accumulated change of obliquity is greateſt at the ſolſtices, the obliquity itſelf being then ſmalleſt.

415 Quantity of preceſſion in a given time.

We muſt in like manner find the accumulated quantity of the preceſſion after a given time, that is, the arch BE for a finite time.

We have ER : CD=ſin. EA : ſin. CA (or coſ. EA)=tan. EA : 1, and EB : ER=1 : ſin. B. Therefore EB : CD=tan. EA : ſin. B. But tan. EA= coſ. E×tan. ES, = coſ. E × $\frac{\text{ſin. long.}}{\text{coſ. long.}} = \frac{qx}{\sqrt{1-x^2}}$. Therefore EB : CD = $\frac{qx}{\sqrt{1-x^2}}p$, and CD = EB : $\frac{\text{ſin. obliq. eclip.}}{\text{tan. long. ⊙}}$. If we now ſubſtitute for CD its value found in N° 40, viz. $\frac{3tkp}{2T}x\dot{x}$, we obtain EB= $\frac{3t}{2T}\times\frac{kqx^2\dot{x}}{\sqrt{1-x^2}}$, the fluxion of the preceſſion of the equinoxes occaſioned by the action of the ſun. The fluent of the variable part $\frac{x^2\dot{x}}{\sqrt{1-x^2}} = x\dot{y}$, of which the fluent is evidently a ſegment of a circle whoſe arch is z and ſine x, that is, $= \frac{z-x\sqrt{1-x^2}}{2}$, and the whole preceſſion, while the ſun deſcribes the arch z, is $\frac{3t}{2T}\times\frac{kq}{2}\left(z-x\sqrt{1-x^2}\right)$. This is the preceſſion of the equinoxes while the ſun moves from the vernal equinox along the arch z of the ecliptic.

In this expreſſion, which conſiſts of two parts, $\frac{3tkq}{4T}z$, and $\frac{3tkq}{4T}\left(-x\sqrt{1-x^2}\right)$, the firſt is incomparably greater than the ſecond, which never exceeds 1″, and is always compenſated in the ſucceeding quadrant. The preceſſion occaſioned by the ſun will be $\frac{3tkq}{4T}z$, and from this expreſſion we ſee that the preceſſion increaſes uniformly, or at leaſt increaſes at the ſame rate with the ſun's longitude z, becauſe the quantity $\frac{3tkq}{4T}$ is conſtant.

In order to make uſe of theſe formulæ, which are now reduced to very great ſimplicity, it is neceſſary to determine the values of the two conſtant quantities $\frac{3tkp}{4T}$, $\frac{3tkq}{4T}$, which we ſhall call N and P, as factors of the nutation and preceſſion. Now t is one ſidereal day, and T is 366¼. k is $\frac{a^2-b^2}{a^2}$, which according to Sir Iſaac Newton is $\frac{231^2-230^2}{231^2}, = \frac{1}{115}$; p and q are the ſine and coſine of 23° 28′, viz. 0,39822 and 0,91729. 416 Mode of uſing the formulæ.

Theſe data give $N = \frac{1}{141030}$ and $P = \frac{1}{61224}$ of which the logarithms are 4.85069 and 5.21308, viz. the arithmetical complements of 5.14931 and 4.78692.

Let us, for an example of the uſe of this inveſtigation, compute the preceſſion of the equinoxes when the ſun has moved from the vernal equinox to the ſummer ſolſtice, ſo that z is 90°, or 324000″. 417 Example of the utility of the inveſtigation.

Log 324000″=z	5.51055
Log P	5.21308
Log 5″,292	0.72363

The preceſſion therefore in a quarter of a year is 5,292 ſeconds; and, ſince it increaſes uniformly, it is 21″,168 annually.

We muſt now recollect the aſſumptions on which this computation proceeds. The earth is ſuppoſed to be homogeneous, and the ratio of its equatorial diameter to its polar axis is ſuppoſed to be that of 231 to 230. If the earth be more or leſs protuberant at the equator, the preceſſion will be greater or leſs in the ratio of this protuberance. The meaſures which have been taken of the degrees of the meridian are very inconſiſtent among themſelves; and although a compariſon of them all indicates a ſmaller protuberancy, nearly $\frac{1}{312}$ inſtead of $\frac{1}{231}$, their differences are too great to leave much confidence in this method. But if this figure be thought more probable, the preceſſion will be reduced to about 17″ annually. But even though the figure of the earth were accurately determined, we have no authority to ſay that it is homogeneous. If it be denſer towards the centre, the momentum of the protuberant matter will not be ſo great as if it were equally denſe with the inferior parts, and the preceſſion will be diminiſhed on this account. Did we know the proportion of the matter in the moon to that in the ſun, we could 418 Aſſumptions on which the computation proceeds.

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could eaſily determine the proportion of the whole obſerved annual preceſſion of $50\frac{1}{3}''$ which is produced by the ſun's action. But we have no unexceptionable data for determining this; and we are rather obliged to infer it from the effect which ſhe produces in diſturbing the regularity of the preceſſion, as will be conſidered immediately. So far, therefore, as we have yet proceeded in this inveſtigation, the reſult is very uncertain. We have only aſcertained unqueſtionably the law which is obſerved in the ſolar preceſſion. It is probable, however, that this preceſſion is not very different from $20''$ annually; for the phenomena of the tides ſhow the diſturbing force of the ſun to be very nearly $\frac{2}{5}$ of the diſturbing force of the moon. Now $20''$ is $\frac{2}{5}$ of $50''$.

419 Effect of the moon's action on the protuberant matter of the earth.

But let us now proceed to conſider the effect of the moon's action on the protuberant matter of the earth; and as we are ignorant of her quantity of matter, and conſequently of her influence in ſimilar circumſtances with the ſun, we ſhall ſuppoſe that the diſturbing force of the moon is to that of the ſun as m to 1. Then (*cæteris paribus*) the preceſſion will be to the ſolar preceſſion π in the ratio of the force and of the time of its action jointly. Let t and T therefore repreſent a periodical month and year, and the lunar preceſſion will be $=\frac{m\pi t}{T}$. This preceſſion muſt be reckoned on the plane of the lunar orbit, in the ſame manner as the ſolar preceſſion is reckoned on the ecliptic. We muſt alſo obſerve, that $\frac{m\pi t}{T}$ repreſents the lunar preceſſion only on the ſuppoſition that the earth's equator is inclined to the lunar orbit in an angle of $23\frac{1}{2}$ degrees. This is indeed the mean inclination; but it is ſometimes increaſed to above 28°, and ſometimes reduced to 18°. Now in the value of the ſolar preceſſion the coſine of the obliquity was employed. Therefore whatever is the angle E contained between the equator and the lunar orbit, the preceſſion will be $=\frac{m\pi t}{T}\cdot\frac{\text{Coſ. E}}{\text{Coſ. }23\frac{1}{2}^{\circ}}$, and it muſt be reckoned on the lunar orbit.

Now let ♈B (fig. 160.) be the immoveable plane of the ecliptic, ♈ED♎F the equator in its firſt ſituation, before it has been deranged by the action of the moon, AGRDBH the equator in its new poſition, after the momentary action of the moon. Let EGNFH be the moon's orbit, of which N is the aſcending node, and the angle N=5° 8′ 46″.

Let N♈ the long. of the node be	z
Sine N♈	x
Coſine N♈	y
Sine ♈ = $23\frac{1}{2}$	a
Coſine ♈	b
Sine N=5.8.46	c
Coſine N	d
Circumference to radius 1,=6,28	e
Force of the moon	m
Solar preceſſion (ſuppoſed = $14\frac{1}{2}''$ by obſervation)	π
Revolution of ☾ =27d$\frac{1}{3}$	t
Revolution of ☉=366$\frac{1}{4}$	T
Revolution of N=18 years 7 months	n

420 Lunar preceſſion in a month reduced to the ecliptic.

In order to reduce the lunar preceſſion to the ecliptic, we muſt recollect that the equator will have the ſame inclination at the end of every half revolution of the ſun or of the moon, that is, when they paſs through the equator, becauſe the ſum of all the momentary changes of its poſition begins again each revolution. Therefore if we neglect the motion of the node during one month, which is only $1\frac{1}{2}$ degrees, and can produce but an inſenſible change, it is plain that the moon produces, in one half revolution, that is, while ſhe moves from H to G, the greateſt difference that ſhe can in the poſition of the equator. The point D, therefore, half way from G to H, is that in which the moveable equator cuts the primitive equator, and DE and DF are each 90°. But S being the ſolſtitial point, ♈S is alſo 90°. Therefore DS=♈E. Therefore, in the triangle DGE, we have ſin. ED : ſin. G = ſin. EG : ſin. D, = EG : D. Therefore D = EG × ſin. G, = EG × ſin. E nearly. Again, in the triangle ♈DA we have ſin. A : ſin. ♈D (or coſ. ♈E) = ſin. D : ſin. ♈A, = D : ♈A. Therefore

$$\text{♈A}=\frac{\text{D}\cdot\text{Coſ. ♈E}}{\text{Sin. A}},=\frac{\text{EG}\cdot\text{Sin. E}\cdot\text{Coſ. ♈E}}{\text{Sin. }23\frac{1}{2}},=\frac{m\pi t}{\text{T}}\;\frac{\text{Sin. E}\cdot\text{Coſ. E}\cdot\text{Coſ. ♈E}}{\text{Sin. ♈}\cdot\text{Coſ. ♈}}.$$

This is the lunar preceſſion produced in the courſe of one month, eſtimated on the ecliptic, not conſtant like the ſolar preceſſion, but varying with the inclination or the angle E or F, which varies both by a change in the angle N, and alſo by a change in the poſition of N on the ecliptic.

421 Nutation in the ſame time,

We muſt find in like manner the nutation SR produced in the ſame time, reckoned on the colure of the ſolſtices RL. We have R : ſin. DS = D : RS, and RS = D · ſin. DS, = D · ſin. ♈E. But D = EG · ſin. E Therefore RS = ED · ſin. E · ſin. ♈E, $=\frac{m\pi t\ \text{Coſ. E}}{\text{T}\cdot\text{Coſ. ♈}}$ × ſin. E × ſin. ♈E. In this expreſſion we muſt ſubſtitute the angle N, which may be conſidered as conſtant during the month, and the longitude ♈N, which is alſo nearly conſtant, by obſerving that ſin. E : ſin. ♈N = ſin. N : ſin. ♈E. Therefore RS $=\frac{m\pi t}{\text{T}}\times\frac{\text{Sin. N}\cdot\text{Sin. ♈N}\cdot\text{Coſ. E.}}{\text{Coſ. ♈}}$

But we muſt exterminate the angle E, becauſe it changes by the change of the poſition of N. Now, in the triangle ♈EN we have coſ. E = coſ. ♈N · ſin. N · ſin. ♈ — coſ. N · coſ. ♈, $=yca-db$. And becauſe the angle E is neceſſarily obtuſe, the perpendicular will fall without the triangle, the coſine of E will be negative, and we ſhall have coſ. E $=bd-acy$. Therefore the nutation for one month will be $=\frac{m\pi t}{\text{T}}\times\frac{cx(bd-acy}{b}$, the node being ſuppoſed all the while in N.

422 may be conſidered as momentary parts of the moon's action.

Theſe two expreſſions of the monthly preceſſion and nutation may be conſidered as momentary parts of the moon's action, correſponding to a certain poſition of the node and inclination of the equator, or, as the fluxions of the whole variable preceſſion and nutation, while the node continually changes its place, and in the ſpace of 18 years makes a complete tour of the heavens.

423 Preceſſion and nutation compared.

We muſt, therefore, take the motion of the node as the fluent of compariſon, or we muſt compare the fluxions of the node's motion with the fluxions of the preceſſion and nutation; therefore, let the longitude of the node be z, and its monthly change $=\dot{z}$; we ſhall then have

t:

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$t : n = \dot{z} : e$, and $t = \frac{n\dot{z}}{e}, = \frac{n\dot{x}}{e\sqrt{1-x^2}}$. Let T be $=1$, in order that n may be 18,6, and substitute for t its value in the fluxion of the nutation, by putting $\sqrt{1-x^2}$ in place of y. By this substitution we obtain $m\pi n\frac{c}{eb}\left(\frac{dbx\dot{x}}{\sqrt{1-x^2}} - acx\dot{x}^2\right)$. The fluent of this is $m\pi n\frac{c}{eb}\left(-db\sqrt{1-x^2} - \frac{acx^2}{2}\right)$. (*Vide* Simpson's Fluxions, § 77). But when x is $=o$, the nutation must be $=o$, because it is from the position in the equinoctial points that all our deviations are reckoned, and it is from this point that the periods of the lunar action recommence. But if we make $x=o$ in this expression, the term $-\frac{acx^2}{2}$ vanishes, and the term $-db\sqrt{1-x^2}$ becomes $=-db$; therefore our fluent has a constant part $+db$; and the complete fluent is $m\pi n\frac{c}{eb}\left(db - db\sqrt{1-x^2} - \frac{acx^2}{2}\right)$. Now this is equal to $m\pi n\frac{c}{eb}$ ($db \times$ versed sine, $z - \frac{1}{4}ac \times$ versed sine $2z$): For the versed sine of z is equal to ($1 -$ cos. z); and the square of the sine of an arch is $\frac{1}{2}$ the versed sine of twice that arch.

This, then, is the whole nutation while the moon's ascending node moves from the vernal equinox to the longitude ♈N$=z$. It is the expression of a certain number of seconds, because π, one of its factors, is the solar precession in seconds; and all the other factors are numbers, or fractions of the radius 1; even e is expressed in terms of the radius 1.

The fluxion of the precession, or the monthly precession, is to that of the nutation as the cotangent of ♈E is to the sine of ♈. This also appears by considering fig. 159. Pp measures the angle A, or change of position of the equator; but the precession itself, reckoned on the ecliptic, is measured by Po, and the nutation by po; and the fluxion of the precession is equal to the fluxion of nutation $\times \frac{\text{cot.}♈\text{E}}{\text{sine }♈}$, but cot. ♈ E $= \frac{ad+bcy}{cx}$; therefore $\frac{\text{cot.}♈\text{E}}{\text{sine }♈} = \frac{ad+bc\sqrt{1-x^2}}{cx}$: This, multiplied into the fluxion of the nutation, gives $\frac{m\pi n}{abe}\left(\frac{abd^2}{\sqrt{1-xx}} + (b^2-a^2)dc - abc^2.\sqrt{1-xx}\right)\dot{x}$ for the monthly precession. The fluent of this $\frac{m\pi n}{abe}\left(ad^2bz + (b^2-a^2)dcx - \frac{1}{2}abc^2z - \frac{1}{2}abc^2x\sqrt{1-x^2}\right)$, or it is equal to $\frac{m\pi n}{abe}\left((d^2-\frac{1}{2}c^2)abz + (b^2-a^2)dcz - \frac{1}{4}abc^2 \text{ sine } 2z\right)$.

Let us now express this in numbers: When the node has made a half revolution, we have $z=180°$, whose versed sine is 2, and the versed sine of $2z$, or 360°, is $=0$; therefore, after half a revolution of the node, the nutation becomes $\frac{m\pi nc}{eb}2bd$. If, in this expression, we supposed $m=2\frac{1}{2}$, and $\pi=14\frac{1}{2}''$, we shall find the nutation to be $19\frac{1}{5}''$.

Now the observed nutation is about 18″. This requires m to be $2\frac{1}{10}$, and $\pi=16\frac{1}{4}''$. But it is evident, that no astronomer can pretend to warrant the accuracy of his observations of the nutation within 1″.

The find the lunar precession during half a revolution of the node, observe, that then z becomes $=\frac{e}{2}$, and the sine of z and of $2z$ vanish, d^2 becomes $1-c^2$, and the precession becomes $\frac{m\pi n}{2}(d^2-\frac{1}{2}c^2), = \frac{m\pi n}{2}(1-\frac{3}{2}c^2)$, and the precession in 18 years is $m\pi n\,\overline{1-\frac{3}{2}c^2}$.

We see, by comparing the nutation and precession for nine years, that they are as $\frac{4cd}{e}$ to $1-\frac{3}{2}c^2$ nearly as 1 to $17\frac{1}{3}$. This gives 313″ of precession, corresponding to 18″, the observed nutation, which is about 35″ of precession annually produced by the moon.

424 Gives the disturbing force and matter of the moon.

And thus we see that the inequality produced by the moon in the precession of the equinoxes, and, more particularly, the nutation occasioned by the variable obliquity of her orbit, enables us to judge of her share in the whole phenomenon; and therefore informs us of her disturbing force, and therefore of her quantity of matter. This phenomenon, and those of the tides, are the only facts which enable us to judge of this matter: and this is one of the circumstances which has caused this problem to occupy so much attention. Dr Bradley, by a nice comparison of his observations with the mathematical theory, as it is called, furnished him by Mr Machin, found that the equation of precession computed by that theory was too great, and that the theory would agree better with the observations, if an ellipse were substituted for Mr Machin's little circle. He thought that the shorter axis of this ellipse, lying in the colure of the solstices, should not exceed 16″. Nothing can more clearly show the astonishing accuracy of Bradley's observations than this remark: for it results from the theory, that the pole must really describe an ellipse, having its shorter axis in the solstitial colure, and the ratio of the axes must be that of 18 to 16,8; for the mean precession during a half revolution of the node is $\frac{m\pi n}{2}\left(d^2-\frac{c^2}{2}\right)$; and therefore for the longitude z, it will be $\frac{zm\pi n}{e}\left(d^2-\frac{c^2}{2}\right)$; when this is taken from the true precession for that longitude, it leaves the equation of precession $\frac{m\pi n}{abe}\left((b^2-a^2)dc\cdot\text{sine } z - \frac{1}{4}abc \text{ sine } 2z\right)$; therefore when the node is in the solstice, and the equation greatest, we have it $= \frac{m\pi ncd}{abe}(b^2-a^2)$. We here neglect the second term as insignificant.

This

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This greatest equation of precession is to $\frac{2 m \pi n c d}{c}$, the nutation of 18″, as $b^2 - a^2$ to $2ab$; that is, as radius to the tangent of twice the obliquity of the ecliptic. This gives the greatest equation of precession 16″,8, not differing half a second from Bradley's observations.

425 Greatest equation of precession.

Thus have we attempted to give some account of this curious and important phenomenon. It is curious, because it affects the whole celestial motions in a very intricate manner, and received no explanation from the more obvious application of mechanical principles, which so happily accounted for all the other appearances. It is one of the most illustrious proofs of Sir Isaac Newton's sagacity and penetration, which catched at a very remote analogy between this phenomenon and the libration of the moon's orbit. It is highly important to the progress of practical and useful astronomy, because it has enabled us to compute tables of such accuracy, that they can be used with confidence for determining the longitude of a ship at sea. This alone fixes its importance: but it is still more important to the philosopher, affording the most incontestable proof of the universal and mutual gravitation of all matter to all matter. It left nothing in the solar system unexplained from the theory of gravity but the acceleration of the moon's mean motion; and this has at last been added to the list of our acquisitions by M. de la Place.

Quæ toties animos veterum torsere Sophorum,
Quæque scholas frustra rauco certamine vexant,
Obvia conspicimus, nube pellente Mathesi,
Jam dubios nulla caligine prægravat error
Queis superûm penetrare domos, atque ardua cœli
Scandere sublimis genii concessit acumen.
Nec fas est proprius mortali attingere divos.

HALLEY.

SECT. X. *Of the Libration of the Moon.*

THE only phenomena which still remain to be explained are the libration of the moon and the motion of the nodes of her equator. The moon in consequence of her rotation round her axis is a little flattened towards the poles; but the attraction of the earth must have lengthened the axis of the moon directed towards that planet. If the moon were homogeneous and fluid, she would assume the form of an ellipsoid, whose shorter axis would pass through her poles of rotation; the longer axis would be directed towards the earth, and in the plane of the moon's equator; and the mean axis, situated in the same plane, would be perpendicular to the two others. The excess of the longer over the shorter would be quadruple the excess of the mean axis over the shorter, and would amount to about $\frac{1}{29711}$, the shorter axis being represented by unity.

It is easy to see, that if the longer axis of the moon deviate a little from the direction of the radius vector, which joins together the centres of the earth and moon, the attraction of the earth will tend to bring it towards that radius just as gravity tends to bring a pendulum towards the vertical position. If the rotation of the satellite had been at first sufficiently rapid to overcome this tendency, the time of a rotation would not have been equal to that of a revolution round the earth, and their difference would have discovered to us successively all the points of the moon's surface. But the angular motions of rotation and revolution having been at first but very little different, the force with which the longer axis separated from the radius vector was not sufficient to overcome the tendency toward the radius vector occasioned by the attraction of the earth. This last tendency, therefore, has rendered the two motions rigidly equal. And, as a pendulum driven from the vertical direction by a very small force constantly returns to it, making small oscillations on each side, in like manner the longer axis of the moon ought to oscillate on each side of the radius vector of her orbit. The libration of the moon then depends upon the small difference which originally subsisted between the angular motions of the moon's rotation and revolution.

Thus we see, that the theory of gravitation explains the equality which subsists between the mean rotation and revolution of the moon. It is only necessary to suppose, that the original difference between them was small. In that case the attraction of the earth would soon reduce them to a state of equality.

The singular coincidence of the nodes of the moon's equator, with those of its orbit, is also owing to the attraction of the earth. This was first demonstrated by La Grange. The planes of the equator and of the orbit of the moon, and the plane which passes through its centre, parallel to the ecliptic, have always nearly the same intersection. The secular movements of the ecliptic neither alter the coincidence of the nodes of these three planes, nor their mean inclination, which the attraction of the earth keeps always the same.

We have now examined all the phenomena of the heavenly bodies, and have found that they are all explicable on the theory of gravitation, and indeed necessary consequences of that theory. The exact coincidence of all the phenomena must be considered as a complete demonstration of the truth of the theory; and indeed places it beyond the reach of every possible objection. With respect to the nature of this force called *gravitation*, nothing whatever is known, nor is it likely that any thing ever will be known. The discussion being evidently above the reach of the human faculties, all the different theories which have been published, explaining it by ethers, &c. have only served to show the weakness of human reason, when it attempts to leave the plain path of experience, and indulge in fancy and conjecture.

APPENDIX.

APPENDIX.

In the preceding article we have endeavoured to give as full a view as poſſible of aſtronomy; avoiding, at the ſame time, the introduction of minute details upon thoſe ſubjects which are not eſſential, that the readers attention might not be diſtracted and diverted from objects of primary importance. But for the ſake of thoſe perſons who may wiſh to indulge their taſte for practical aſtronomy, we have thought proper to ſubjoin an appendix; in which we ſhall give, in the firſt place, the rules for calculating eclipſes, and in the ſecond, a deſcription of the moſt important aſtronomical inſtruments.

I. *Method of calculating Eclipſes.*

The method of conſtructing tables for the calculation of eclipſes will be underſtood from the following obſervations.

The motions of the ſun and moon are obſerved to be continually accelerated from the apogee to the perigee, and as gradually retarded from the perigee to the apogee; being ſloweſt of all when the mean anomaly is nothing, and ſwifteſt of all when it is ſix ſigns.

When the luminary is in its apogee or perigee, its place is the ſame as it would be if its motion were equable in all parts of its orbit. The ſuppoſed equable motions are called *mean;* the unequable are juſtly called the *true.*

The mean place of the ſun or moon is always forwarder than the true place, whilſt the luminary is moving from its apogee to its perigee: and the true place is always forwarder than the mean, whilſt the luminary is moving from its perigee to its apogee. In the former caſe, the anomaly is always leſs than ſix ſigns; and in the latter caſe, more.

It has been found, by a long ſeries of obſervations, that the ſun goes through the ecliptic, from the vernal equinox to the ſame equinox again, in 365 days 5 hours 48 minutes 55 ſeconds; from the firſt ſtar of Aries to the ſame ſtar again, in 365 days 6 hours 9 minutes 24 ſeconds; and from his apogee to the ſame again, in 365 d ys 6 hours 14 minutes 0 ſeconds.—The firſt of theſe is called the *ſolar year;* the ſecond the *ſidereal year;* and the third the *anomaliſtic year.* So that the ſolar year is 20 minutes 29 ſeconds ſhorter than the ſidereal; and the ſidereal year is four minutes 36 ſeconds ſhorter than the anomaliſtic. Hence it appears, that the equinoctial point, or interſection of the ecliptic and equator at the beginning of Aries, goes backward with reſpect to the fixed ſtars, and that the ſun's apogee goes forward.

It is alſo obſerved, that the moon goes through her orbit, from any given fixed ſtar to the ſame ſtar again, in 27 days 7 hours 43 minutes 4 ſeconds at a mean rate; from her apogee to her apogee again, in 27 days 13 hours 18 minutes 43 ſeconds; and from the ſun to the ſun again, in 29 days 12 hours 44 minutes $3\frac{1}{10}$ ſeconds. This ſhows that the moon's apogee moves forward in the ecliptic, and that at a much quicker rate than the ſun's apogee does: ſince the moon is 5 hours 55 minutes 39 ſeconds longer in revolving from her apogee to her apogee again, than from any ſtar to the ſame ſtar again.

The moon's orbit croſſes the ecliptic in two oppoſite points, which are called her *nodes:* and it is obſerved, that ſhe revolves ſooner from any node to the node again, than from any ſtar to the ſtar again, by 2 hours 38 minutes 27 ſeconds; which ſhows that her nodes move backward, or contrary to the order of ſigns in the ecliptic.

The time in which the moon revolves from the ſun to the ſun again (or from change to change) is called a *lunation;* which, according to Dr Pound's mean meaſures, would always conſiſt of 29 days 12 hours 44 minutes 3 ſeconds 2 thirds 58 fourths, if the motions of the ſun and moon were always equable. Hence 12 mean lunations contain 354 days 8 hours 48 minutes 36 ſeconds 35 thirds 40 fourths, which is 10 days 21 hours 11 minutes 23 ſeconds 24 thirds 20 fourths leſs than the length of a common Julian year, conſiſting of 365 days 6 hours; and 13 mean lunations contain 383 days 21 hours 32 minutes 39 ſeconds 38 thirds 38 fourths, which exceeds the length of a common Julian year, by 18 days 15 hours 32 minutes 39 ſeconds 38 thirds 38 fourths.

The mean time of new moon being found for any given year and month, as ſuppoſe for March 1700 old ſtyle, if this mean new moon falls later than the 11th day of March, then 12 mean lunations added to the time of this mean new moon will give the time of the mean new moon in March 1701, after having thrown off 365 days. But when the mean new moon happens to be before the 11th of March, we muſt add 13 mean lunations, in order to have the time of mean new moon in March the year following; always taking care to ſubtract 365 days in common years, and 366 days in leap years, from the ſum of this addition.

Thus, A. D. 1700, old ſtyle, the time of mean new moon in March was the 8th day, at 16 hours 11 minutes 25 ſeconds after the noon of that day (viz. at 11 minutes 25 ſeconds paſt four in the morning of the 9th day), according to common reckoning. To this we muſt add 13 mean lunations, or 383 days 21 hours 32 minutes 39 ſeconds 38 thirds 38 fourths, and the ſum will be 392 days 13 hours 44 minutes 4 ſeconds 38 thirds 38 fourths: from which ſubtract 365 days, becauſe the year 1701 is a common year, and there will remain 27 days 13 hours 44 minutes 4 ſeconds 38 thirds 38 fourths for the time of mean new moon in March, A. D. 1701.

Carrying on this addition and ſubtraction till A. D. 1703, we find the time of mean new moon in March that year to be on the 6th day, at 7 hours 21 minutes 17 ſeconds 49 thirds 46 fourths paſt noon; to which add 13 mean lunations, and the ſum will be 390 days 4 hours 53 minutes 57 ſeconds 28 thirds 20 fourths; from which ſubtract 366 days, becauſe the year 1704 is a leap-year, and there will remain 24 days 4 hours 53 minutes 57 ſeconds 28 thirds 20 fourths, for the time of mean new moon in March A. D. 1704.

In this manner was the firſt of the following tables conſtructed to ſeconds, thirds, and fourths; and then wrote out to the neareſt ſeconds. The reaſon why we choſe to begin the year with March, was to avoid the inconvenience of adding a day to the tabular time in leap-years after February, or ſubtracting a day therefrom

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from in January and February in those years; to which all tables of this kind are subject, which begin the year with January, in calculating the times of new or full moons.

The mean anomalies of the sun and moon, and the sun's mean motion from the ascending node of the moon's orbit, are set down in Table III. from 1 to 13 mean lunations. These numbers, for 13 lunations, being added to the radical anomalies of the sun and moon, and to the sun's mean distance from the ascending node, at the time of mean new moon in March 1700 (Table I.), will give their mean anomalies, and the sun's mean distance from the node, at the time of mean new moon in March 1701, and being added for 12 lunations to those for 1701, give them for the time of mean new moon in March 1702. And so on as far as you please to continue the table (which is here carried on to the year 1800), always throwing off 12 signs when their sum exceeds 12, and setting down the remainder as the proper quantity.

If the number belonging to A. D. 1700 (in Table I.) be subtracted from those belonging to 1800, we shall have their whole differences in 100 complete Julian years; which accordingly we find to be 4 days 8 hours 10 minutes 52 seconds 15 thirds 40 fourths, with respect to the time of mean new moon. These being added together 60 times (always taking care to throw off a whole lunation when the days exceed $29\frac{1}{2}$) make up 60 centuries, or 6000 years, as in Table VI. which was carried on to seconds, thirds, and fourths; and then wrote out to the nearest seconds. In the same manner were the respective anomalies and the sun's distance from the node found, for these centurial years; and then (for want of room) wrote out only to the nearest minutes, which is sufficient in whole centuries. By means of these two tables, we may find the time of any mean new moon in March, together with the anomalies of the sun and moon, and the sun's distance from the node at these times, within the limits of 6000 years either before or after any given year in the 18th century; and the mean time of any new or full moon in any given month after March, by means of the third and fourth tables, within the same limits, as shown in the precepts for calculation.

Thus it would be a very easy matter to calculate the time of any new or full moon, if the sun and moon moved equably in all parts of their orbits. But we have already shown, that their places are never the same as they would be by equable motions, except when they are in apogee or perigee; which is, when their mean anomalies are either nothing or six signs: and that their mean places are always forwarder than their true places, whilst the anomaly is less than six signs; and their two places are forwarder than the mean, whilst the anomaly is more.

Hence it is evident, that whilst the sun's anomaly is less than six signs, the moon will overtake him, or be opposite to him, sooner than she could if his motion were equable; and later whilst his anomaly is more than six signs. The greatest difference that can possibly happen between the mean and true time of new or full moon, on account of the inequality of the sun's motion, is 3 hours 48 minutes 28 seconds: and that is, when the sun's anomaly is either 3 signs 1 degree, or 8 signs 29 degrees; sooner in the first case, and later in the last.—In all other signs and degrees of anomaly, the difference is gradually less, and vanishes when the anomaly is either nothing or six signs.

The sun is in his apogee on the 30th of June, and in his perigee on the 30th of December, in the present age: so that he is nearer the earth in our winter than in our summer.—The proportional difference of distance, deduced from the difference of the sun's apparent diameter at these times, is as 983 to 1017.

The moon's orbit is dilated in winter, and contracted in summer; therefore the lunations are longer in winter than in summer. The greatest difference is found to be 22 minutes 29 seconds; the lunations increasing gradually in length whilst the sun is moving from his apogee to his perigee, and decreasing in length whilst he is moving from his perigee to his apogee.—On this account, the moon will be later every time in coming to her conjunction with the sun, or being in opposition to him, from December till June, and sooner from June till December, than if her orbit had continued of the same size all the year round.

As both these differences depend on the sun's anomaly, they may be fitly put together into one table, and called *The annual or first equation of the mean to the true syzigy*, (See Table VII.) This equational difference is to be subtracted from the time of the mean syzigy when the sun's anomaly is less than six signs, and added when the anomaly is more.—At the greatest it is 4 hours 10 minutes 57 seconds, viz. 3 hours 48 minutes 28 seconds, on account of the sun's unequal motion, and 22 minutes 29 seconds, on account of the dilatation of the moon's orbit.

This compound equation would be sufficient for reducing the mean time of new or full moon to the true time thereof, if the moon's orbit were of a circular form, and her motion quite equable in it. But the moon's orbit is more elliptical than the sun's, and her motion in it is so much the more unequal. The difference is so great, that she is sometimes in conjunction with the sun, or in opposition to him, sooner by 9 hours 47 minutes 54 seconds, than she would be if her motion were equable; and at other times as much later. The former happens when her mean anomaly is 9 signs 4 degrees, and the latter when it is 2 signs 26 degrees. See Table IX.

At different distances of the sun from the moon's apogee, the figure of the moon's orbit becomes different. It is longest of all, or most eccentric, when the sun is in the same sign and degree either with the moon's apogee or perigee; shortest of all, or least eccentric, when the sun's distance from the moon's apogee is either three signs or nine signs; and at a mean state when the distance is either 1 sign 15 degrees, 4 signs 15 degrees, 7 signs 15 degrees, or 10 signs 15 degrees. When the moon's orbit is at its greatest eccentricity, her apogeal distance from the earth's centre is to her perigeal distance therefrom, as 1067 is to 933; when least eccentric, as 1043 is to 957; and when at the mean state, as 1055 is to 945.

But the sun's distance from the moon's apogee is equal to the quantity of the moon's mean anomaly at the time of new moon, and by the addition of 6 signs it becomes equal in quantity to the moon's mean anomaly at the time of full moon. Therefore, a table may be constructed so as to answer to all the various inequalities depending on the different eccentricities of the moon's orbit, in the syzigies, and called *The se-*

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cond equation of the mean to the true ſyzigy. (See Table IX.): and the moon's anomaly, when equated by Table VIII. may be made the proper argument for taking out this ſecond equation of time; which muſt be added to the former equated time, when the moon's anomaly is leſs than ſix ſigns, and ſubtracted when the anomaly is more.

There are ſeveral other inequalities in the moon's motion, which ſometimes bring on the true ſyzigy a little ſooner, and at other times keep it back a little later, than it would otherwiſe be; but they are ſo ſmall, that they may be all omitted except two; the former of which (ſee Table X.) depends on the difference between the anomalies of the ſun and moon in the ſyzigies, and the latter (ſee Table XI.) depends on the ſun's diſtance from the moon's nodes at theſe times. The greateſt difference ariſing from the former is 4 minutes 58 ſeconds; and from the latter, 1 minute 34 ſeconds.

The tables here inſerted being calculated by Mr Ferguſon according to the methods already given, he gives the following directions for their uſe.

356 Directions for the uſe of thoſe tables.

To calculate the true Time of New or Full Moon.

Precept I. If the required time be within the limits of the 18th century, write out the mean time of new moon in March, for the propoſed year, from Table I. in the old ſtyle, or from Table II. in the new; together with the mean anomalies of the ſun and moon, and the ſun's mean diſtance from the moon's aſcending node. If you want the time of full moon in March, and the half lunation at the foot of Table III. with its anomalies, &c. to the former numbers, if the new moon falls before the 15th of March; but if it falls after, ſubtract the half lunation, with the anomalies, &c. belonging to it, from the former numbers, and write down the reſpective ſums or remainders.

II. In theſe additions or ſubtractions, obſerve, that 60 ſeconds make a minute, 60 minutes make a degree, 30 degrees make a ſign, and 12 ſigns make a circle. When you exceed 12 ſigns in addition, reject 12, and ſet down the remainder. When the number of ſigns to be ſubtracted is greater than the number you ſubtract from, add 12 ſigns to the leſſer number, and then you will have a remainder to ſet down. In the tables ſigns are marked thus ^{s}, degrees thus ^{o}, minutes thus ′, and ſeconds thus ″.

III. When the required new or full moon is in any given month after March, write out as many lunations with their anomalies, and the ſun's diſtance from the node from Table III. as the given month is after March, ſetting them in order below the number taken out for March.

IV. Add all theſe together, and they will give the mean time of the required new or full moon, with the mean anomalies and ſun's mean diſtance from the aſcending node, which are the arguments for finding the proper equations.

V. With the number of days added together, enter Table IV. under the given month; and againſt that number you have the day of mean new or full moon in the left-hand column, which ſet before the hours, minutes, and ſeconds, already found.

But (as it will ſometimes happen) if the ſaid number of days fall ſhort of any in the column under the given month, add one lunation and its anomalies, &c. (from Table III.) to the foreſaid ſums, and then you will have a new ſum of days wherewith to enter Table IV. under the given month, where you are ſure to find it the ſecond time, if the firſt falls ſhort.

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VI. With the ſigns and degrees of the ſun's anomaly, enter Table VII. and therewith take out the annual or firſt equation for reducing the mean ſyzigy to the true; taking care to make proportions in the table for the odd minutes and ſeconds of anomaly, as the table gives the equation only to whole degrees.

Obſerve, in this and every other caſe of finding equations, that if the ſigns are at the head of the table, their degrees are at the left hand, and are reckoned downwards; but if the ſigns are at the foot of the table, their degrees are at the right hand, and are counted upward; the equation being in the body of the table, under or over the ſigns, in a collateral line with the degrees. The titles *Add* or *Subtract* at the head or foot of the tables where the ſigns are found, ſhow whether the equation is to be added to the mean time of new or full moon, or to be ſubtracted from it. In this table, the equation is to be ſubtracted, if the ſigns of the ſun's anomaly are found at the head of the table; but it is to be added, if the ſigns are at the foot.

VII. With the ſigns and degrees of the ſun's mean anomaly, enter Table VIII. and take out the equation of the moon's mean anomaly; ſubtract this equation from her mean anomaly, if the ſigns of the ſun's anomaly be at the head of the table, but add it if they are at the foot; the reſult will be the moon's equated anomaly, with which enter Table IX. and take out the ſecond equation for reducing the mean to the true time of new or full moon; adding this equation, if the ſigns of the moon's anomaly are at the head of the table, but ſubtracting it if they are at the foot; and the reſult will give you the mean time of the required new or full moon twice equated, which will be ſufficiently near for common almanacs.—But when you want to calculate an eclipſe, the following equations muſt be uſed: thus,

VIII. Subtract the moon's equated anomaly from the ſun's mean anomaly, and with the remainder in ſigns and degrees enter Table X. and take out the third equation, applying it to the former equated time, as the titles *Add* or *Subtract* do direct.

IX. With the ſun's mean diſtance from the aſcending node enter Table XI. and take out the equation anſwering to that argument, adding it to, or ſubtracting it from, the former equated time, as the titles direct, and the reſult will give the time of new or full moon, agreeing with well regulated clocks or watches very near the truth. But to make it agree with the ſolar, or apparent time, you muſt apply the equation of natural days, taken from an equation-table, as it is leap-year, or the firſt, ſecond, or third after. This, however, unleſs in very nice calculations, needs not be regarded, as the difference between true and apparent time is never very conſiderable.

The method of calculating the time of any new or full moon without the limits of the 18th century will be ſhown further on. And a few examples compared with the precepts will make the whole work plain.

N. B. The tables begin the day at noon, and reckon forward from thence to the noon following.—Thus, March the 31ſt, at 22 h. 30 m. 25 ſec. of tabular time is April 1ſt (in common reckoning) at 30 m. 25 ſec. after 10 o'clock in the morning.

EXAMPLE

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EXAMPLE I.

Required the true time of New Moon in April 1764, *New Style?*

By the Precepts.	New Moon.				Sun's Anomaly.				Moon's Anomaly.				Sun from Node.			
	D.	H.	M.	S.	s	°	'	"	s	°	'	"	s	°	'	"
March 1764,	2	8	55	36	8	2	20	0	10	13	35	21	11	4	54	48
Add 1 Lunation,	29	12	44	3	0	29	6	19	0	25	49	0	1	0	40	14
Mean New Moon,	31	21	39	39	9	1	26	19	11	9	24	21	0	5	35	2
First Equation,	+	4	10	40	11	10	59	18	+	1	34	57	Sun from Node, and Arg. 4th equation.			
Time once equated,	32	1	50	19	9	20	27	1	11	10	59	18				
Second equation,	—	3	24	49	Arg. 3d equation.				Arg. 2d equation.							
Time twice equated,	31	22	25	30												
Third Equation,		+	4	37												
Time thrice equated,	31	22	30	7												
Fourth Equation,			+	18												
True New Moon,	31	22	30	25												
Equation of days,		—	3	48												
Apparent time,	31	22	26	37												

So the true time is 22 h. 30 min. 25 fec. after the noon of the 31ft March; that is, April 1ft, at 30 min. 25 fec. after ten in the morning. But the apparent time is 26 min. 37 fec. after ten in the morning.

EXAMPLE II.

Qu. *The true time of the Full Moon in May* 1762, *New Style?*

By the Precepts.	New Moon.				Sun's Anomaly.				Moon's Anomaly.				Sun from Node.			
	D.	H.	M.	S.	s	°	'	"	s	°	'	"	s	°	'	"
March 1762,	24	15	18	24	8	23	48	16	1	23	59	11	10	18	49	14
Add 2 lunations,	59	1	28	6	1	28	12	39	1	21	38	1	2	1	20	28
New Moon, May,	22	16	46	30	10	22	0	55	3	15	37	12	0	20	9	42
Subt. ½ Lunation,	14	18	22	2	0	14	33	10	6	12	54	30	0	15	20	7
Full Moon, May,	7	22	24	28	10	7	27	45	9	2	42	42	0	4	49	35
First Equation,	+	3	16	36	9	3	57	18	+	1	14	36	Sun from Node, and Arg. 4th equation.			
Time once equated,	8	1	41	4	1	3	30	27	9	3	57	18				
Second Equation,	—	9	47	53	Arg. 3d equation.				Arg. 2d equation.							
Time twice equated,	7	15	53	11												
Third Equation,		—	2	36												
Time thrice equated,	7	15	50	35												
Fourth Equation,			+	15												
The Full Moon,	7	15	50	50												

Anf. May 7th at 15h. 50min. 50fec. paft noon, *viz.* May 8th at 3 h. 50 min. 50 fec. in the morning.

To calculate the time of New and Full Moon in a given year and month of any particular century between the Chriftian era and the 18*th century.*

Precept I. Find a year of the fame number in the 18th century with that of the year in the century propofed, and take out the mean time of new moon in March, old ftyle, for that year, with the mean anomalies and fun's mean diftance from the node at that time, as already taught.

II. Take as many complete centuries of years from Table VI. as, when fubtracted from the abovefaid year in the 18th century, will anfwer to the given year; and take out the firft mean new moon and its anomalies, &c. belonging to the faid centuries, and fet them below thofe taken out for March in the 18th century.

III. Subtract the numbers belonging to thefe centuries from thofe of the 18th century, and the remainders will be the mean time and anomalies, &c. of new moon in March, in the given year of the century propofed.—Then, work in all refpects for the true time of new or full moon, as fhown in the above precepts and examples.

IV. If the days annexed to thefe centuries exceed the number of days from the beginning of March taken out in the 18th century, add a lunation and its anomalies, &c. from Table III. to the time and anomalies of new moon in March, and then proceed in all refpects as above. This circumftance happens in Example V.

EXAMPLE

EXAMPLE III.

Required the true time of Full Moon in April, Old Style, A. D. 30?

From 1730 subtract 1700 (or 17 centuries) and there remains 30.

By the Precepts.	New Moon				Sun's Anomaly.				Moon's Anomaly.				Sun from Node.			
	D.	H.	M.	S.	s.	°	′	″	s.	°	′	″	s.	°	′	″
March 1730,	7	12	34	16	8	18	4	31	9	0	32	17	1	23	17	16
Add ½ Lunation,	14	18	22	2	0	14	33	10	6	12	54	30	0	15	20	7
Full Moon,	22	6	56	18	9	2	37	41	3	13	26	47	2	8	37	23
1700 years subtr.	14	17	36	42	11	28	46	0	10	29	36	0	4	29	23	0
Full ☽ March A. D. 30.	7	13	19	36	9	3	51	41	4	13	50	47	9	9	14	23
Add 1 Lunation,	29	12	44	3	0	29	6	19	0	25	49	0	1	0	40	14
Full Moon, April,	6	2	3	39	10	2	58	0	5	9	39	47	10	9	54	37
First Equation,	+	3	28	4	5	10	58	40	+	1	18	53	Sun from Node, and Arg. fourth equation.			
Time once equated,	6	5	31	43	4	21	59	20	5	10	58	40				
Second Equation,	+	2	57	48	Arg. 3d equation.				Arg. 2d equation.							
Time twice equated,	6	8	29	31												
Third Equation,		—	2	54												
Time thrice equated,	6	8	26	37												
Fourth Equation,		—	1	33												
True Full Moon, April,	6	8	25	4												

Hence it appears, that the true time of Full Moon in April, A. D. 30, old style, was on the 6th day, at 25 m. 4 s. past eight in the evening.

To Calculate the true time of New or Full Moon in any given year and month before the Christian era.

Precept I. Find a year in the 18th century, which being added to the given number of years before Christ diminished by one, shall make a number of complete centuries.

II. Find this number of centuries in Table VI. and subtract the time and anomalies belonging to it from those of the mean new moon in March, the above found year of the 18th century; and the remainder will denote the time and anomalies, &c. of mean new moon in March, the given year before Christ.—Then, for the true time thereof in any month of that year, proceed as above taught.

EXAMPLE IV.

Required the true time of New Moon in May, Old Style, the year before Christ 585?

The years 584 added to 1716, make 2300, or 23 centuries.

By the Precepts.	New Moon.				Sun's Anomaly.				Moon's Anomaly.				Sun from Node.			
	D	H.	M.	S	s	°	′	″	s	°	′	″	s	°	′	″
March 1716,	11	17	33	29	8	22	50	39	4	4	14	2	4	27	17	5
2300 years subtract,	11	5	57	53	11	19	47	0	1	5	59	0	7	25	27	0
March before Christ 585,	0	11	35	36	9	3	3	39	2	28	15	2	9	1	50	5
Add 3 Lunations,	88	14	12	9	2	27	18	58	2	17	27	1	3	2	0	42
May before Christ 585,	28	1	47	45	0	0	22	37	5	15	42	3	0	3	50	47
First Equation,		—	1	37	5	15	41	17			—	46	Sun from Node, and Arg. fourth equation.			
Time once equated,	28	1	46	8	6	14	41	20	5	19	41	17				
Second Equation,	+	2	15	1	Arg. 3d equation.				Arg. 2d equation.							
Time twice equated,	28	4	1	9												
Third Equation,		+	1	9												
Time thrice equated,	28	4	2	18												
Fourth Equation,			+	12												
True new moon,	28	4	2	30												

So the true time was May 28th, at 2 minutes 30 seconds past four in the afternoon.

These Tables are calculated for the meridian of London; but they will serve for any other place, by subtracting four minutes from the tabular time, for every degree that the meridian of the given place is westward of London, or adding four minutes for every degree that the meridian of the given place is eastward: as in

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EXAMPLE V.

Required the true time of Full Moon at Alexandria in Egypt in September, Old Style, the year before Christ 201?

The years 200 added to 1800, make 2000 or 20 cyphers.

By the Precepts.	New Moon.				Sun's Anomaly.				Moon's Anomaly.				Sun from Node.			
	D.	H.	M.	S.	s	°	'	"	s	°	'	"	s	°	'	"
March 1800,	13	0	22	17	8	23	19	55	10	7	52	36	11	3	58	24
Add 1 Lunation,	29	12	44	3	0	29	6	19	0	25	49	0	1	0	40	14
From the ſum,	42	13	6	20	9	22	26	14	11	3	41	36	0	4	38	38
Subtract 2000 years,	27	18	9	19	0	8	50	0	0	15	42	0	6	27	45	0
N. M. bef. Chr. 201,	14	18	57	1	9	13	36	14	10	17	59	36	5	6	53	38
Add { 6 Lunations,	177	4	24	18	5	24	37	56	5	4	54	3	6	4	1	24
half Lunations,	14	18	22	2	0	14	33	10	6	12	54	30	0	15	20	7
Full moon, September,	22	17	43	21	3	22	47	20	10	5	48	9	11	26	15	9
Firſt Equation,	—	3	52	6	10	4	19	55	—	1	28	14	Sun from Node,			
Time once equated,	22	13	51	15	5	18	27	25	10	4	19	55	and Argument			
Second Equation,	—	8	25	4	Arg. 3d equation.				Arg. 2d equation.				fourth equation.			
Time twice equated,	22	5	26	11												
Third Equation,			—	58												
Time thrice equated,	22	5	25	13												
Fourth Equation,			—	12												
True time at London,	22	5	25	1												
Add for Alexandria,		2	1	27												
True time there,	22	7	26	28												

Thus it appears, that the true time of Full Moon, at Alexandria, in September, old ſtyle, the year before Chriſt 201, was the 22d day, at 26 minutes 28 ſeconds after ſeven in the evening.

EXAMPLE VI.

Required the true time of Full Moon at Babylon in October, Old Style, the 4008 year before the firſt year of Chriſt, or 4007 before the year of his birth?

The years 4007 added to 1793, make 5800, or 58 centuries.

By the Precepts.	New Moon.				Sun's Anomaly.				Moon's Anomaly.				Sun from Node.			
	D.	H.	M.	S.	s	°	'	"	s	°	'	"	s	°	'	"
March 1793,	30	9	13	55	9	10	16	11	8	7	37	58	7	6	18	26
Subtract 5800 years,	15	12	38	7	10	21	35	0	6	24	43	0	9	13	1	0
N. M. bef. Chr. 4007,	14	20	35	48	10	18	41	11	1	12	54	58	9	23	17	26
Add { 7 Lunations,	206	17	8	21	6	23	44	15	6	0	43	3	7	4	41	38
half Lunations,	14	18	22	2	0	14	33	10	6	12	54	30	0	15	20	7
Full moon, October,	22	8	6	11	5	26	58	36	1	26	32	31	5	13	19	11
Firſt Equation,		—	13	26	1	26	27	26		—	5	5	Sun from Node,			
Time once equated,	22	7	52	45	4	0	31	10	1	26	27	26	and Argument			
Second Equation,	+	8	29	21	Arg. 3d equation.				Arg. 2d equation.				fourth equation.			
Time twice equated,	22	16	22	6												
Third Equation,		—	4	10												
Time thrice equated,	22	16	17	56												
Fourth Equation,			—	51												
Full moon at London,	22	16	17	5												
Add for Babylon,		2	25	41												
True time there,	22	18	42	46												

So that, on the meridian of London, the true time was October 23d, at 17 minutes 5 ſeconds paſt four in the morning; but at Babylon, the true time was October 23d, at 42 minutes 46 ſeconds paſt ſix in the morning.—This is ſuppoſed by ſome to have been the year of the creation.

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To calculate the true time of New or Full Moon in any given year and month after the 18th century.

Precept I. Find a year of the same number in the 18th century with that of the year proposed, and take out the mean time and anomalies, &c. of new moon in March, old style, for that year, in Table I.

II. Take so many years from Table VI. as when added to the above-mentioned year in the 18th century will answer to the given year in which the new or full moon is required; and take out the first new moon, with its anomalies for these complete centuries.

III. Add all these together, and then work in all respects as above shown, only remember to subtract a lunation and its anomalies, when the abovesaid addition carries the new moon beyond the 31st of March; as in the following example.

EXAMPLE VII.

Required the true time of New Moon in July, Old Style, A. D. 2180?

Four centuries (or 400 years) added to A. D. 1780, make 2180.

By the Precepts.	New Moon.				Sun's Anomaly.				Moon's Anomaly.				Sun from Node.			
	D.	H.	M.	S.	s	°	′	″	s	°	′	″	s	°	′	″
March 1780,	23	23	1	34	9	4	18	13	1	21	7	47	10	18	21	1
Add 400 years,	17	8	43	29	0	13	24	0	10	1	28	0	6	17	49	0
From the Sum	41	7	45	13	9	17	42	13	11	22	35	47		6	10	1
Subtract 1 Lunation	29	12	44	3	0	29	6	19	0	25	49	0		0	40	14
New Moon March 2180,	11	19	1	10	8	18	35	54	10	26	46	47	4	5	29	47
Add 4 Lunations,	118	2	56	12	3	26	25	17	3	13	16	2	4	2	40	56
New Moon July 2180,	7	21	57	22	0	15	1	11	2	10	2	49	8	8	10	43
First Equation,	—	1	3	39	3	9	38	37		—	24	12	Sun from Node and Argument fourth equation.			
Time once equated,	7	20	53	43	10	5	22	34	2	9	38	37				
Second Equation,	+	9	24	8	Arg. 3d equation.				Arg. 2d equation.							
Time twice equated,	8	6	17	51												
Third Equation,		+	3	56	True time, July 8th, at 22 minutes 55 seconds past six in the evening.											
Time thrice equated,	8	6	21	47												
Fourth Equation,		+	1	8												
True time, July,	8	6	22	55												

In keeping by the old style, we are always sure to be right, by adding or subtracting whole hundreds of years to or from any given year in the 18th century. But in the new style we may be very apt to make mistakes, on account of the leap year's not coming in regularly every fourth year: and therefore, when we go without the limits of the 18th century, we had best keep to the old style, and at the end of the calculation reduce the time to the new. Thus, in the 22d century there will be fourteen days difference between the styles; and therefore the true time of new moon in this last example being reduced to the new style will be the 22d of July, at 22 minutes 55 seconds past six in the evening.

To calculate the true place of the Sun for any given moment of time.

Precept I. In Table XII. find the next lesser year in number to that in which the sun's place is sought, and write out his mean longitude and anomaly answering thereto: to which add his mean motion and anomaly for the complete residue of years, months, days, hours, minutes, and seconds, down to the given time, and this will be the sun's mean place and anomaly at that time, in the old style, provided the said time be in any year after the Christian era. *See the first following example.*

II. Enter Table XIII. with the sun's mean anomaly, and making proportions for the odd minutes and seconds thereof, take out the equation of the sun's centre: which, being applied to his mean place as the title *Add* or *Subtract* directs, will give his true place or longitude from the vernal equinox, at the time for which it was required.

III. To calculate the sun's place for any time in a given year before the Christian era, take out his mean longitude and anomaly for the first year thereof, and from these numbers subtract the mean motions and anomalies for the complete hundreds or thousands next above the given year; and to the remainders, add those for the residue of years, months, &c. and then work in all respects as above. *See the second example following.*

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Of Calculating Eclipses, &c.

EXAMPLE I.

Required the Sun's true place, March 20th, Old Style, 1764, at 22 hours 30 minutes 25 seconds past Noon? In common reckoning, March 21st, at 10 hours 30 minutes in the Forenoon.

		Sun's Longitude.				Sun's Anomaly.			
		s	°	'	"	s	°	'	"
To the radical year after Christ - -	1701	9	20	43	50	6	13	1	0
Add complete years - -	60	0	0	27	12	11	29	26	0
	3	11	29	17	0	11	29	14	0
	March	1	28	9	11	1	28	9	0
Bissextile Days -	20		20	41	55		20	41	55
Hours -	22			54	13			54	13
Minutes -	30			1	14			1	14
Seconds -	25				1				1
Sun's mean place at the given time - -		0	10	14	36	9	1	27	23
Equation of the Sun's centre, add - -			1	55	36	Mean Anomaly.			
Sun's true place at the same time - -		0	12	10	12	or ♈ 12	10	12	

EXAMPLE II.

Required the Sun's true place, October 23d, Old Style, at 16 hours 57 minutes past Noon, in the 4008th year before the year of Christ 1; which was the 4007th before the year of his birth, and the year of the Julian period 706.

By the Precepts.		Sun's Longitude.				Sun's Anomaly.			
		s	°	'	"	s	°	'	"
From the radical numbers after Christ -	1	9	7	53	10	6	28	48	0
Subtract those for 5000 complete years - -		1	7	46	40	10	13	25	0
Remains for a new radix - -		8	0	6	30	8	15	23	0
To which add, to bring it to the given time: complete years -	900	0	6	48	0	11	21	37	0
	80	0	0	36	16	11	29	15	0
	12	0	0	5	26	11	29	53	0
	October	8	29	4	54	8	29	4	0
Days	23		22	40	12		22	40	12
Hours	16			39	26			39	26
Minutes	57			2	20			2	20
Sun's mean place at the given time - -		6	0	3	4	5	28	33	58
Equation of the sun's centre subtract - -				3	4	Sun's Anomaly.			
Sun's true place at the same time - -		6	0	0	0	or ♎ 0	0	0	

So that in the meridian of London, the sun was then just entering the sign ♎ Libra, and consequently was upon the point of the autumnal equinox.

If to the above time of the autumnal equinox at London, we add 2 h. 25 m. 41 sec. for the longitude of Babylon, we shall have for the time of the same equinox, at that place, October 23d, at 19 h. 22 m. 41 sec.; which, in the common way of reckoning, is October 24th, at 22 m. 41 sec. past seven in the morning.

And it appears by Example VI. that in the same year the true time of full moon at Babylon was October 23d, at 42 m. 46 sec. after six in the morning; so that the autumnal equinox was on the day next after the day of full moon.—The dominical letter for that year was G, and consequently the 24th of October was on a Wednesday.

To find the Sun's distance from the Moon's ascending node, at the time of any given new or full moon: and consequently, to know whether there is an eclipse at that time or not.

The sun's distance from the moon's ascending node is the argument for finding the moon's fourth equation in the syzigies; and therefore it is taken into all the foregoing examples in finding the times thereof. Thus, at the time of mean new moon in April 1764, the sun's mean

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mean distance from the ascending node is $0^s\ 5°\ 35'\ 2''$. See Example I.

The descending node is opposite to the ascending one, and they are just six signs distant from each other.

When the sun is within 17 degrees of either of the nodes at the time of new moon, he will be eclipsed at that time; and when he is within 12 degrees of either of the nodes at the time of full moon, the moon will be then eclipsed. Thus we find, that there will be an eclipse of the sun at the time of new moon in April 1764.

But the true time of that new moon comes out by the equations to be 50 minutes 46 seconds later than the mean time thereof, by comparing these times in the above example: and therefore we must add the sun's motion from the node during that interval to the above mean distance $0^s\ 5°\ 35'\ 2''$, which motion is found in Table XII. for 50 minutes 46 seconds, to be $2'\ 12''$. And to this we must apply the equation of the sun's mean distance from the node in Table XV. found by the sun's anomaly, which, at the mean time of new moon in Example I. is $9^s\ 1°\ 26'\ 19''$; and then we shall have the sun's true distance from the node, at the true time of new moon, as follows:

	Sun from Node. s	°	′	″
At the mean time of new moon in April 1764	0	5	35	2
Sun's motion from the node for 50 minutes			2	10
46 seconds				2
Sun's mean distance from node at true new moon	0	5	37	14
Equation of mean distance from node, add		2	5	0
Sun's true distance from the ascending node	0	7	42	14

Which being far within the above limit of 17 degrees, shows that the sun must then be eclipsed.

And now we shall show how to project this, or any other eclipse, either of the sun or moon.

To project an Eclipse of the Sun.

In order to this, we must find the 10 following elements by means of the tables.

1. The true time of conjunction of the sun and moon; and at that time. 2. The semidiameter of the earth's disk, as seen from the moon, which is equal to the moon's horizontal parallax. 3. The sun's distance from the solstitial colure to which he is then nearest. 4. The sun's declination. 5. The angle of the moon's visible path with the ecliptic. 6. The moon's latitude. 7. The moon's true horary motion from the sun. 8. The sun's semidiameter. 9. The moon's. 10. The semidiameter of the penumbra.

We shall now proceed to find these elements for the sun's eclipse in April 1764.

To find the true time of new moon. This, by Example I. is found to be on the first day of the said month, at 30 minutes 25 seconds after ten in the morning.

2. *To find the moon's horizontal parallax, or semidiameter of the earth's disk, as seen from the moon.* Enter Table XVII. with the signs and degrees of the moon's anomaly (making proportions, because the anomaly is in the table only to every 6th degree), and thereby take out the moon's horizontal parallax; which for the above time, answering to the anomaly $11^s\ 9°\ 24'\ 21''$, is $54'\ 43''$.

3. *To find the sun's distance from the nearest solstice, viz. the beginning of Cancer, which is 3^s or 90° from the beginning of Aries.* It appears by Example I. (where the sun's place is calculated to the above time of new moon), that the sun's longitude from the beginning of Aries is then $0^s\ 12°\ 10'\ 12''$: that is, the sun's place at that time is ♈ Aries, $12°\ 10'\ 12''$.

	s	°	′	″
Therefore from - -	3	0	0	0
Subtract the sun's longitude or place	0	12	10	12
Remains the sun's distance from the solstice ♋ =	2	17	49	48

Or $77°\ 49'\ 48''$; each sign containing 30 degrees.

4. *To find the sun's declination.* Enter Table XIV. with the signs and degrees of the sun's true place, viz. $0^s\ 12°$, and making proportions for the $10'\ 12''$, take out the sun's declination answering to his true place, and it will be found to be $4°\ 49'$ north.

5. *To find the moon's latitude.* This depends on her distance from her ascending node, which is the same as the sun's distance from it at the time of new moon; and is thereby found in Table XVI.

But we have already found that the sun's equated distance from the ascending node, at the time of new moon in April 1764, is $0^s\ 7°\ 42'\ 14''$. See above.

Therefore, enter Table XVI. with 0 signs at the top, and 7 and 8 degrees at the left hand, and take out $36'$ and $39''$, the latitude for 7°; and $41'\ 51''$, the latitude for 8°: and by making proportions between these latitudes for the $42'\ 14''$, by which the moon's distance from the node exceeds 7 degrees, her true latitude will be found to be $40'\ 18''$ north ascending.

6. *To find the moon's true horary motion from the sun.* With the moon's anomaly, viz. $11^s\ 9°\ 24'\ 21''$, Table XVII. and take out the moon's horary motion; which, by making proportions in that Table, will be found to be $30'\ 22''$. Then, with the sun's anomaly, $9^s\ 1°\ 26'\ 19''$, take out his horary motion $2'\ 28''$ from the same table; and subtracting the latter from the former, there will remain $27'\ 54''$ for the moon's true horary motion from the sun.

7. *To find the angle of the moon's visible path with the ecliptic.* This, in the projection of eclipses, may be always rated at $5°\ 35'$, without any sensible error.

8, 9. *To find the semidiameters of the sun and moon.* These are found in the same table, and by the same arguments, as their horary motions. In the present case, the sun's anomaly gives his semidiameter $16'\ 6''$, and the moon's anomaly gives her semidiameter $14'\ 57''$.

10. *To find the semidiameter of the penumbra.* Add the moon's semidiameter to the sun's, and their sum will be the semidiameter of the penumbra, viz. $31'\ 3''$.

Now collect these elements, that they may be found the more readily when they are wanted in the construction of this eclipse.

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1. True time of new moon in April, 1764 - -	1	10	30	25
	°	′	″	
2. Semidiameter of the earth's disk	0	54	53	
3. Sun's distance from the nearest solst.	77	49	48	
4. Sun's declination, north	4	49	0	
5. Moon's latitude, north ascending	0	40	18	
6. Moon's horary motion from the sun	0	27	54	
7. Angle of the moon's visible path with the ecliptic	5	35	0	
8. Sun's semidiameter		16	6	
9. Moon's semidiameter		14	57	
0. Semidiameter of the penumbra		31	3	

To project an Eclipse of the Sun geometrically.

Fig. 158. *a.* Make a scale of any convenient length, as AC, and divide it into as many equal parts as the earth's semidisk contains minutes of a degree; which, at the time of the eclipse in April 1764, is 54′ 53″. Then, with the whole length of the scale as a radius, describe the semicircle AMB upon the centre C; which semicircle shall represent the northern half of the earth's enlightened disk, as seen from the sun.

Upon the centre C raise the straight line CH, perpendicular to the diameter ACB; so ACB shall be a part of the ecliptic, and CH its axis.

Being provided with a good sector, open it to the radius CA in the line of chords; and taking from thence the chord of 23½ degrees in your compasses, set it off both ways from H, to *g* and to *h*, in the periphery of the semidisk; and draw the straight line *g*V*h*, in which the north pole of the disk will be always found.

When the sun is in Aries, Taurus, Gemini, Cancer, Leo, and Virgo, the north pole of the earth is enlightened by the sun: but whilst the sun is in the other six signs, the south pole is enlightened, and the north pole is in the dark.

And when the sun is in Capricorn, Aquarius, Pisces, Aries, Taurus, and Gemini, the northern half of the earth's axis C XII P lies to the right hand of the axis of the ecliptic, as seen from the sun; and to the left hand, whilst the sun is in the other six signs.

Open the sector till the radius (or distance of the two 90's) of the sines be equal to the length of V*h*, and take the sine of the sun's distance from the solstice (77° 49′ 48″) as nearly as you can guess, in your compasses, from the line of the sines, and set off that distance from V to P in the line *g*V*h*, because the earth's axis lies to the right hand of the axis of the ecliptic in this case, the sun being in Aries; and draw the straight line C XII P for the earth's axis, of which P is the north pole. If the earth's axis had lain to the left hand from the axis of the ecliptic, the distance VP would have been set off from V towards *g*.

To draw the parallel of latitude of any given place, as suppose London, or the path of that place on the earth's enlightened disk as seen from the sun, from sunrise till sunset, take the following method.

Subtract the latitude of London, 51½° from 90°, and the remainder 38½° will be the colatitude, which take in your compasses from the line of chords, making CA or CB the radius, and set it from *h* (where the earth's axis meets the periphery of the disk) to VI and VI, and draw the occult or dotted line VI K VI. Then, from the points where this line meets the earth's disk, set off the chord of the sun's declination 4° 49′ to D and F, and to E and G, and connect these points by the two occult lines F XII G and DLE.

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Bisect LK XII in K, and through the point K draw the black line VI K VI. Then making CB the radius of a line of sines on the sector, take the colatitude of London 38½° from the sines in your compasses, and set it both ways from K to VI and VI. These hours will be just in the edge of the disk at the equinoxes, but at no other time in the whole year.

With the extent K VI taken into your compasses, set one foot in K (in the black line below the occult one) as a centre, and with the other foot describe the semicircle VI 7 8 9 10, &c. and divide it into 12 equal parts. Then from these points of division draw the occult lines 7*p*, 8*o*, 9*n*, &c. parallel to the earth's axis C XII P.

With the small extent K XII as a radius, describe the quadrantal arc XII *f*, and divide it into six equal parts, as XII, *a*, *ab*, *bc*, *cd*, *de*, and *ef*; and through the division points *a*, *b*, *c*. *d*, *e*, draw the occult lines VII *e* V, VIII *d* IV, IX *c* III, X *b* II, and XI, *a* I, all parallel to VI K VI, and meeting the former occult lines 7*p* 8*o*, &c. in the points VII VIII IX X XI, V IV III II and I: which points shall mark the several situations of London on the earth's disk, at these hours respectively, as seen from the sun; and the elliptic curve VI VII VII, &c. being drawn through these points, shall represent the parallel of latitude, or path of London on the disk, as seen from the sun, from its rising to its setting.

N. B. If the sun's declination had been south, the diurnal path of London would have been on the upper side of the line VI K VI, and would have touched the line DLE in L. It is requisite to divide the horary spaces into quarters (as some are in the figure), and, if possible, into minutes also.

Make CB the radius of a line of chords on the sector, and take therefrom the chord of 5° 35′, the angle of the moon's visible path with the ecliptic, set it off from H to M on the left hand of CH, the axis of the ecliptic, because the moon's latitude is north ascending. Then draw CM for the axis of the moon's orbit, and bisect the angle MCH by the right line C*z*. If the moon's latitude had been north descending, the axis of her orbit would have been on the right hand from the axis of the ecliptic.——N. B. The axis of the moon's orbit lies the same way when her latitude is south ascending as when it is north ascending; and the same way when south descending as when north descending.

Take the moon's latitude 40′ 18″ from the scale CA in your compasses, and set it from *i* to *x* in the bisecting line C*z*, making *ix* parallel to C*y*: and through *x*, at right angles to the axis of the moon's orbit CM, drawn the straight line N *wxy* S for the path of the penumbra's centre over the earth's disk.—The point *w*, in the axis of the moon's orbit, is that where the penumbra's centre approaches nearest to the centre of the earth's disk, and consequently in the middle of the general eclipses: the point *x* is that where the conjunction of

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of the ſun and moon falls, according to equal time by the tables; and the point *y* is the ecliptical conjunction of the ſun and moon.

Take the moon's true horary motion from the ſun, 27′ 54″, in your compaſſes, from the ſcale CA (every diviſion of which is a minute of a degree), and with that extent make marks along the path of the penumbra's centre; and divide each ſpace from mark to mark into 60 equal parts or horary minutes, by dots; and ſet the hours to every 60th minute in ſuch a manner, that the dot ſignifying the inſtant of new moon by the tables may fall into the point *x*, half way between the axis of the moon's orbit and the axis of the ecliptic; and then the reſt of the dots will ſhow the points of the earth's diſk, where the penumbra's centre is at the inſtants denoted by them, in its tranſit over the earth.

Apply one ſide of a ſquare to the line of the penumbra's path, and move the ſquare backwards and forwards until the other ſide of it cuts the ſame hour and minute (as at *m* and *m*) both in the path of London and in the path of the penumbra's centre; and the particular minute or inſtant which the ſquare cuts at the ſame time on both paths ſhall be the inſtant of the viſible conjunction of the ſun and moon, or greateſt obſcuration of the ſun, at the place for which the conſtruction is made, namely London, in the preſent example; and this inſtant is at 37½ minutes paſt ten o'clock in the morning; which is 17 minutes five ſeconds later than the tabular time of true conjunction.

Take the ſun's ſemidiameter, 16′ 6″, in your compaſſes, from the ſcale CA, and ſetting one foot on the path of London, at *m*, namely at 47½ minutes paſt ten, with the other foot deſcribe the circle UY, which ſhall repreſent the ſun's diſk as ſeen from London at the greateſt obſcuration.—Then take the moon's ſemidiameter, 14′ 57″, in your compaſſes from the ſame ſcale, and ſetting one foot in the path of the penumbra's centre at *m*, in the 47½ minutes after ten, with the other foot deſcribe the circle TY for the moon's diſk, as ſeen from London, at the time when the eclipſe is at the greateſt, and the portion of the ſun's diſk which is hid or cut off by the moon's will ſhow the quantity of the eclipſe at that time; which quantity may be meaſured on a line equal to the ſun's diameter, and divided into 12 equal parts for digits.

Laſtly, take the ſemidiameter of the penumbra, 31′ 3″, from the ſcale CA in your compaſſes; and ſetting one foot in the line of the penumbra's centre path, on the left hand from the axis of the ecliptic, direct the other foot toward the path of London; and carry that extent backwards and forwards till both the points of the compaſſes fall into the ſame inſtants in both the paths: and theſe inſtants will denote the time when the eclipſe begins at London.—Then do the like on the right hand of the axis of the ecliptic; and where the points of the compaſſes fall into the ſame inſtants in both the paths, they will ſhow at what time the eclipſe ends at London.

Theſe trials give 20 minutes after nine in the morning for the beginning of the eclipſe at London, at the points N and O; 47½ minutes after ten, at the points *m* and *n*, for the time of greateſt obſcuration; and 18 minutes after twelve, at R and S, for the time when the eclipſe ends; according to mean or equal time.

From theſe times we muſt ſubtract the equation of natural days, viz. 3 minutes 48 ſeconds, in leap year April 1. and we ſhall have the apparent times; namely, 9 hours 16 minutes 12 ſeconds for the beginning of the eclipſe, 10 hours 43 minutes 42 ſeconds for the time of greateſt obſcuration, and 12 hours 14 minutes 12 ſeconds for the time when the eclipſe ends. But the beſt way is to apply this equation to the true equal time of new moon, before the projection be begun; as is done in Example I. For the motion or poſition of places on the earth's diſk anſwer to apparent or ſolar time.

In this conſtruction it is ſuppoſed, that the angle under which the moon's diſk is ſeen, during the whole time of the eclipſe, continues invariably the ſame; and that the moon's motion is uniform and rectilineal during that time. But theſe ſuppoſitions do not exactly agree with the truth; and therefore, ſuppoſing the elements given by the tables to be accurate, yet the times and phaſes of the eclipſe, deduced from its conſtruction will not anſwer exactly to what paſſeth in the heavens; but may be at leaſt two or three minutes wrong, though done with the greateſt care. Moreover, the paths of all places of conſiderable latitudes are nearer the centre of the earth's diſk as ſeen from the ſun than thoſe conſtructions make them; becauſe the diſk is projected as if the earth were a perfect ſphere, although it is known to be a ſpheroid. Conſequently, the moon's ſhadow will go farther northward in all places of northern latitude, and farther ſouthward in all places of ſouthern latitude, than it is ſhown to do in theſe projections.——According to Meyer's Tables, this eclipſe was about a quarter of an hour ſooner than either theſe tables, or Mr Flamſtead's, or Dr Halley's, make it; and was not annular at London. But M. de la Caille's make it almoſt central.

The projection of lunar eclipſes.

When the moon is within 12 degrees of either of her nodes at the time when ſhe is full, ſhe will be eclipſed, otherwiſe not.

We find by Example II. that at the time of mean full moon in May 1762, the ſun's diſtance from the aſcending node was only 4° 49′ 35″; and the moon being then oppoſite to the ſun, muſt have been juſt as near her deſcending node, and was therefore eclipſed.

The elements for conſtructing an eclipſe of the moon are eight in number, as follows:

1. The true time of full moon; and at that time, 2. The moon's horizontal parallax. 3. The ſun's ſemidiameter. 4. The moon's. 5. The ſemidiameter of the earth's ſhadow at the moon. 6. The moon's latitude. 7. The angle of the moon's viſible path with the ecliptic. 8. The moon's true horary motion from the ſun.——Therefore,

1. *To find the true time of new or full moon.* Work as already taught in the precepts.—Thus we have the true time of full moon in May 1762 (ſee Example II. page 562) on the 8th day, at 50 minutes 50 ſeconds paſt three o'clock in the morning.

2. *To find the moon's horizontal parallax.* Enter Table XVII. with the moon's mean anomaly (at the above full) 9^s 2° 42′ 42″, and thereby take out her horizontal parallax; which, by making the requiſite proportions, will be found to be 57′ 23″.

3, 4. *To find the ſemidiameters of the ſun and moon.* Enter Table XVII. with their reſpective anomalies, the ſun's being 10^s 7° 27′ 45″ (by the above example) and the moon's 9^s 2° 42′ 42″; and thereby take out their reſpective ſemidiameters; the ſun's 15′ 56″, and the moon's 15′ 38″.

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5. *To find the semidiameter of the earth's shadow at the moon.* Add the sun's horizontal parallax, which is always 10′, to the moon's which in the present case is 37′ 23″, the sum will be 57′ 33″, from which subtract the sun's semidiameter 15′ 56″, and there will remain 41′ 37″ for the semidiameter of that part of the earth's shadow which the moon then passes through.

6. *To find the moon's latitude.* Find the sun's true distance from the ascending node (as already taught at the true time of full moon; and this distance increased by six signs will be the moon's true distance from the same node; and consequently the argument for finding her true latitude.

Thus, in Example II. the sun's mean distance from the ascending node was $0^s\ 40^\circ\ 49'\ 35''$, at the time of mean full moon; but it appears by the example, that the true time thereof was six hours 33 minutes 38 seconds sooner than the mean time; and therefore we must subtract the sun's motion from the node (found in Table XII.) during this interval from the above mean distance $0^s\ 4^\circ\ 49'\ 35''$, in order to have his mean distance from it at the true time of full moon. Then to this apply the equation of his mean distance from the node, found in Table XV. by his mean anomaly $10^s\ 7^\circ\ 27'\ 45''$: and lastly add six signs: so shall the moon's true distance from the ascending node be found as follows:

	s	°	′	″
Sun from node at mean full moon	0	4	49	35
His motion from it in 6 hours			15	35
33 minutes			1	26
38 seconds				2
Sum, subtract from the uppermost line			17	3
Remains his mean distance at true full moon	0	4	32	32
Equation of his mean distance, add		1	38	0
Sun's true distance from the node	0	6	10	32
To which add	6	0	0	0
And the sum will be	6	6	10	32

Which is the moon's true distance from her ascending node at the true time of her being full; and consequently the argument for finding her true latitude at that time.—Therefore, with this argument enter Table XVI. making proportions between the latitudes belonging to the 6th and 7th degree of the argument at the left hand (the signs being at top) for the 10′ 32″, and it will give 32′ 21″ for the moon's true latitude, which appears by the table to be south descending.

7. *To find the angle of the moon's visible path with the ecliptic.* This may be stated at 5° 35′, without any error of consequence in the projection of the eclipse.

8. *To find the moon's true horary motion from the sun.* With their respective anomalies take out their horary motions from Table XVII. and the sun's horary motion subtracted from the moon's, leaves remaining the moon's true horary motion from the sun: in the present case 30′ 32″.

Now collect these elements together for use.

	D.	H.	M.	S.
1. True time of full moon in May, 1762	8	3	50	50
		°	′	″
2. Moon's horizontal parallax		0	57	23
3. Sun's semidiameter		0	15	56
4. Moon's semidiameter		0	15	38
5. Semidiameter of the earth's shadow at the moon		0	41	37
6. Moon's true latitude, south descending		0	32	21
7. Angle of her visible path with the ecliptic		5	35	0
8. Her true horary motion from the sun		0	30	52

These elements being found for the construction of the moon's eclipse in May 1762, proceed as follows:

Make a scale of any convenient length, as WX (fig. 159. *a.*), and divide it into 60 equal parts, each part standing for a minute of a degree.

Draw the right line ACB (fig. 160. *a.*) for part of the ecliptic, and CD perpendicular thereto for the southern part of its axis; the moon having south latitude.

Add the semidiameters of the moon and earth's shadow together, which in this eclipse will make 57′ 15″; and take this from the scale in your compasses, and setting one foot in the point C as a centre, with the other foot describe the semicircle ADB; in one point of which the moon's centre will be at the beginning of the eclipse, and in another at the end thereof.

Take the semidiameter of the earth's shadow, 41′ 37″, in your compasses from the scale, and setting one foot in the centre C, with the other foot describe the semicircle KLM for the southern half of the earth's shadow, because the moon's latitude is south in this eclipse.

Make CD equal to the radius of a line of chords on the sector, and set off the angle of the moon's visible path with the ecliptic, 5° 35′, from D to E, and draw the right line CFE for the southern half of the axis of the moon's orbit lying to the right hand from the axis of the ecliptic CD, because the moon's latitude is south descending.—It would have been the same way (on the other side of the ecliptic) if her latitude had been north descending, but contrary in both cases if her latitude had been either north ascending or south ascending.

Bisect the angle DCE by the right line C*g*, in which line the true equal time of opposition of the sun and moon falls as given by the table.

Take the moon's latitude, 32′ 21″, from the scale with your compasses, and set it from C to G in the line CG*g*; and through the point G, at right angles to CFE, draw the right line PHGFN for the path of the moon's centre. Then F shall be the point in the earth's shadow, where the moon's centre is at the middle of the eclipse; G, the point where her centre is at the tabular time of her being full; and H, the point where her centre is at the instant of her ecliptical opposition.

Take the moon's horary motion from the sun, 30′ 52″, in your compasses from the scale; and with that extent make marks along the line of the moon's path PGN: then divide each space from mark to mark into 60 equal parts, or horary minutes, and set the hours to the proper dots in such a manner, that the dot signifying the instant of full moon (viz. 50 minutes 50 seconds after III in the morning) may be in the point G, where the line of the moon's path cuts the line that bisects the angle DCE.

Take the moon's semidiameter, 15′ 38″, in your compasses from the scale, and with that extent, as a radius, upon the points N, F, and P, as centres, describe the circle Q for the moon at the beginning of the eclipse, when she touches the earth's shadow at V; the circle R for the moon at the middle of the eclipse; and the circle S for the moon at the end of the eclipse, just leaving the earth's shadow at W.

The point N denotes the instant when the eclipse began, namely, at 15 minutes 10 seconds after II in the morning; the point F the middle of the eclipse at 47 minutes 44 seconds past III; and the point P the end of the eclipse, at 18 minutes after V.—At the greatest obscuration the moon was 10 digits eclipsed.

TABLE I.

TABLE I. *The mean time of New Moon in March, Old Style; with the mean Anomalies of the Sun and Moon, and the Sun's mean distance from the Moon's ascending Node, from A. D.* 1700 *to A. D.* 1800 *inclusive.*

A. D.	Mean New Moon in March.				Sun's Mean Anomaly.				Moon's mean Anomaly.				Sun's mean Dist. from the Node.			
	D.	H.	M.	S.	s	°	′	″	s	°	′	″	s	°	′	″
1700	8	16	11	25	8	19	58	48	1	22	30	37	6	14	31	7
1701	27	13	44	5	9	8	20	59	0	28	7	42	7	23	14	8
1702	16	22	32	41	8	27	36	51	11	7	55	47	8	1	16	55
1703	6	7	21	18	8	16	52	43	9	17	43	52	8	9	19	42
1704	24	4	53	57	9	5	14	54	8	23	20	57	9	18	2	43
1705	13	13	42	34	8	24	30	47	7	3	9	2	9	26	5	30
1706	2	22	31	11	8	13	46	39	5	12	57	7	10	4	8	17
1707	21	20	3	50	9	2	8	50	4	18	34	13	11	12	51	18
1708	10	4	52	27	8	21	24	43	2	28	22	18	11	20	54	5
1709	29	2	25	7	9	9	46	54	2	3	59	24	0	29	37	6
1710	18	11	13	43	8	29	2	47	0	13	47	30	1	7	39	54
1711	7	20	2	20	8	18	18	39	10	23	35	36	1	15	42	41
1712	25	17	34	59	9	6	40	51	9	29	12	42	2	14	25	43
1713	15	2	23	36	8	25	56	43	8	9	0	47	3	2	28	30
1714	4	11	12	13	8	15	12	35	6	18	48	52	3	10	31	17
1715	23	8	44	52	9	3	34	47	5	24	25	57	4	19	14	18
1716	11	17	33	29	8	22	50	39	4	4	14	2	4	27	17	5
1717	1	2	22	5	8	12	6	32	2	14	2	8	5	5	19	52
1718	19	23	54	45	9	0	28	44	1	19	39	13	6	14	2	54
1719	9	8	43	22	8	19	44	37	11	29	27	18	6	22	5	41
1720	27	6	16	1	9	8	6	49	11	5	4	24	8	0	48	45
1721	16	15	4	38	8	27	22	41	9	14	52	29	8	8	51	29
1722	5	23	53	14	8	16	38	33	7	24	40	34	8	16	54	16
1723	24	21	25	54	9	5	0	45	7	0	17	40	9	25	37	18
1724	13	6	14	31	8	24	16	37	5	10	5	45	10	3	40	5
1725	2	15	3	7	8	13	32	29	3	19	53	50	10	11	42	52
1726	21	12	35	47	9	1	54	41	2	25	30	56	11	20	25	54
1727	10	21	24	23	8	21	10	34	1	5	19	1	11	28	28	41
1728	28	18	57	3	9	9	52	46	0	10	56	7	1	7	11	42
1729	18	3	45	40	8	28	48	39	10	20	44	12	1	15	14	29
1730	7	12	34	16	8	18	4	31	9	0	32	17	1	23	17	16
1731	26	10	6	56	9	6	26	42	8	6	9	23	3	2	0	17
1732	14	18	55	33	8	25	42	34	6	15	57	28	3	10	3	4
1733	4	3	44	9	8	14	58	26	4	25	45	33	3	18	5	51
1734	23	1	16	49	9	3	20	38	4	1	22	39	4	26	48	53
1735	12	10	5	25	8	22	36	30	2	11	10	44	5	4	51	40
1736	0	18	54	2	8	11	52	22	0	20	58	49	5	12	54	27
1737	19	16	26	42	9	0	14	34	11	26	35	55	6	21	37	29
1738	9	1	15	18	8	19	30	26	10	6	24	0	6	29	40	16
1739	27	22	47	58	9	7	52	38	9	12	1	6	8	8	23	18
1740	16	7	36	34	8	27	8	30	7	21	49	11	8	16	26	5
1741	5	16	25	11	8	16	24	22	6	1	37	16	8	24	28	52
1742	24	13	57	52	9	4	46	34	5	7	14	22	10	3	11	54
1743	13	22	46	27	8	24	2	27	3	17	2	27	10	1	14	41
1744	2	7	35	4	8	13	18	20	1	26	50	32	10	19	17	28
1745	21	5	7	44	9	1	40	32	1	2	27	38	11	28	0	30
1746	10	13	56	20	8	20	56	24	11	12	15	43	0	6	3	17
1747	29	11	29	0	9	9	18	36	10	17	52	49	1	14	46	19
1748	17	20	17	36	8	28	34	28	8	27	40	54	1	22	49	5
1749	7	5	6	13	8	17	50	20	7	7	28	59	2	0	51	52
1750	26	2	38	53	9	6	12	32	6	13	6	5	3	9	34	53
1751	15	11	27	29	8	25	28	24	4	22	54	10	3	17	37	40
1752	3	20	16	6	8	14	44	16	3	2	42	15	3	25	40	27

A. D.	Mean New Moon in March.				Sun's mean Anomaly.				Moon's mean Anomaly.				Sun's mean Dist. from the Node.			
	D.	H.	M.	S.	s	°	′	″	s	°	′	″	s	°	′	″
1753	22	17	48	45	9	3	6	28	2	8	19	21	5	4	23	28
1754	12	2	37	22	8	22	22	20	0	18	7	26	5	12	26	15
1755	1	11	25	59	8	11	38	12	10	27	55	31	5	20	29	2
1756	19	8	58	38	9	0	0	24	10	3	32	37	6	29	12	3
1757	8	17	47	15	8	19	16	16	8	13	20	42	7	7	14	50
1758	27	15	19	54	9	7	38	28	7	18	57	48	8	15	57	52
1759	17	0	8	31	8	26	54	20	5	28	45	54	8	24	0	39
1760	5	8	57	8	8	16	10	12	4	8	34	0	9	2	3	26
1761	24	6	29	47	9	4	32	24	3	14	11	6	10	10	46	27
1762	13	15	18	24	8	23	48	16	1	23	59	11	10	18	49	14
1763	3	0	7	1	8	13	4	8	0	3	47	16	10	26	52	1
1764	20	21	39	40	9	1	26	20	11	9	24	21	0	5	35	2
1765	10	6	28	17	8	20	42	13	9	19	12	26	0	13	37	49
1766	29	4	0	56	9	9	4	20	8	24	49	32	1	22	20	51
1767	18	12	49	33	8	28	20	17	7	4	37	37	2	0	23	38
1768	6	21	38	10	8	17	36	9	5	14	25	42	2	8	26	25
1769	25	19	10	40	9	5	58	21	4	20	2	48	3	17	9	27
1870	15	3	59	26	8	25	14	13	2	29	50	53	3	25	12	14
1771	4	12	48	2	8	14	30	5	1	9	38	58	4	3	15	1
1772	22	10	20	43	9	2	52	17	0	15	16	4	5	11	58	3
1773	11	19	9	19	8	22	8	9	10	25	4	9	5	20	0	50
1774	1	3	57	55	8	11	24	1	9	4	52	14	5	28	3	37
1775	20	1	30	35	8	29	46	13	8	10	29	20	7	6	46	38
1776	8	10	19	12	8	19	2	5	6	20	17	25	7	14	49	25
1777	27	7	51	51	9	7	24	17	5	25	54	31	8	23	32	26
1778	16	16	40	28	8	26	40	9	4	5	42	36	9	1	35	13
1779	6	1	29	4	8	15	56	1	2	15	30	41	9	9	38	0
1780	23	23	1	44	8	4	18	13	1	21	7	47	10	18	21	1
1781	13	7	50	21	8	23	34	5	0	0	55	52	10	26	23	48
1782	2	16	38	57	8	12	49	58	10	10	43	57	11	4	26	35
1783	21	14	11	37	9	1	12	10	9	16	21	3	0	13	9	36
1784	9	23	0	13	8	20	28	3	7	26	9	8	0	21	12	23
1785	28	20	32	53	9	8	50	15	7	1	46	14	1	29	55	25
1786	18	5	21	30	8	28	6	7	5	11	34	19	2	7	58	12
1787	7	14	10	6	8	17	21	59	3	21	22	24	2	16	0	59
1788	25	11	42	46	9	5	44	11	2	26	59	30	3	24	44	1
1789	14	20	31	23	8	25	0	3	1	6	47	35	4	2	46	48
1790	4	5	19	59	8	14	15	55	11	16	35	40	4	10	49	35
1791	23	2	52	39	9	2	38	7	10	22	12	46	5	19	32	37
1792	11	11	41	15	8	21	53	59	9	2	0	52	5	27	35	24
1793	30	9	13	55	9	10	16	11	8	7	37	58	7	6	18	26
1794	19	18	2	32	8	29	32	3	6	17	26	4	7	14	21	13
1795	9	2	51	8	8	18	47	55	4	27	14	9	7	22	24	0
1796	27	0	23	48	9	7	10	7	4	2	51	14	9	1	7	1
1797	16	9	12	24	8	26	25	59	2	12	39	19	9	9	9	48
1798	5	18	1	1	8	15	41	51	0	22	27	25	9	17	12	35
1799	24	15	33	41	9	4	4	3	11	28	4	31	10	25	55	37
1800	13	0	22	17	8	23	19	55	10	7	52	36	11	3	58	24

TABLE II. *Mean New Moon, &c. in March, New Style, from A. D.* 1752 *to A. D.* 1800.

Y. of Chr.	Mean New Moon in March.				Sun's mean Anomaly.				Moon's mean Anomaly.				Sun's mean Dist. from the Node.			
	D.	H.	M.	S.	s	°	′	″	s	°	′	″	s	°	′	″
1752	14	20	16	6	8	14	44	16	3	2	42	15	3	25	40	27
1753	4	5	4	42	8	4	0	8	1	12	30	20	4	3	43	14
1754	23	2	37	22	8	22	22	20	0	18	7	26	5	12	26	15
1755	12	11	25	59	8	11	38	12	10	27	55	31	5	20	29	2
1756	30	8	58	38	9	0	0	24	10	3	32	37	6	29	12	3
1757	19	17	47	15	8	19	16	16	8	13	20	42	7	7	14	50
1758	9	2	35	51	8	8	32	8	6	23	8	47	7	15	17	38
1759	28	0	8	31	8	26	54	20	5	28	45	54	8	24	0	39
1760	16	8	57	8	8	16	10	12	4	8	34	0	9	2	3	26
1761	5	17	45	44	8	5	26	4	2	18	22	5	9	10	6	13
1762	24	15	18	24	8	23	48	16	1	23	59	11	10	18	49	14
1763	14	0	7	1	8	13	4	8	0	3	47	16	10	26	52	1
1764	2	8	55	36	8	2	20	0	10	13	35	21	11	4	54	48
1765	21	6	28	17	8	20	42	13	9	19	12	26	0	13	37	49
1766	10	15	16	53	8	9	58	5	7	29	0	31	0	21	40	37
1767	29	12	49	33	8	28	20	17	7	4	37	37	2	0	23	38
1768	17	21	38	9	8	17	36	9	5	14	25	42	2	8	26	25
1769	7	6	26	46	8	6	52	1	3	24	13	47	2	16	29	13
1770	26	3	59	26	8	25	14	13	2	29	50	53	3	25	12	14
1771	15	12	48	2	8	14	30	5	1	9	38	58	4	3	15	1
1772	3	21	36	39	8	3	45	57	11	19	27	3	4	11	17	48
1773	22	19	9	19	8	22	8	9	10	25	4	9	5	20	0	50
1774	12	3	57	55	8	11	24	1	9	4	52	14	5	28	3	37
1775	1	12	46	31	8	0	39	53	7	14	40	19	6	6	6	24
1776	19	10	19	12	8	19	2	5	6	20	17	25	7	14	49	25
1777	8	19	7	48	8	8	17	57	5	0	5	30	7	22	52	12
1778	27	16	40	28	8	26	40	9	4	5	42	36	9	2	35	13
1779	17	1	29	4	8	15	56	1	2	15	30	41	9	9	38	0
1780	5	10	17	40	8	5	11	53	0	25	18	46	9	17	40	47
1781	24	7	50	21	8	23	34	5	0	0	55	52	10	26	23	48
1782	13	16	38	57	8	12	49	58	10	10	43	57	11	4	26	35
1783	3	1	27	33	8	2	5	50	8	20	32	2	11	12	29	22
1784	20	23	0	13	8	20	28	3	9	26	9	8	0	21	12	23
1785	10	7	48	50	8	9	43	55	6	5	57	13	0	29	15	10
1786	29	5	21	30	8	28	6	7	5	11	34	19	2	7	58	12
1787	18	14	10	6	8	17	21	59	3	21	22	24	2	16	0	59
1788	6	22	58	42	8	6	37	51	2	1	10	29	2	24	3	46
1789	25	20	31	23	8	25	0	3	1	6	47	35	4	2	46	48
1790	15	5	19	59	8	14	15	55	11	16	35	40	4	10	49	35
1791	4	14	8	35	8	3	31	47	9	26	23	45	4	18	52	22
1792	22	11	41	15	8	21	53	59	9	2	0	52	5	27	35	24
1793	11	20	29	51	8	11	9	51	7	11	48	57	6	5	38	11
1794	30	18	2	32	8	29	32	3	6	17	26	4	7	14	21	13
1795	20	2	51	8	8	18	47	55	4	27	14	9	7	22	24	0
1796	8	11	39	44	8	8	3	47	3	7	2	14	8	0	26	47
1797	27	9	12	24	8	26	25	59	2	12	39	19	9	9	9	48
1798	16	18	1	1	8	15	41	51	0	22	27	25	9	17	12	35
1799	6	2	49	37	8	4	57	43	11	2	15	30	9	25	15	22
1800	25	0	22	17	8	23	19	55	10	7	52	36	11	3	58	24

TABLE III. *Mean Anomalies, and Sun's mean Distance from the Node, for* 13 *mean Lunations.*

N	Mean Lunations.				Sun's mean Anomaly.				Moon's mean Anomaly.				Sun's mean Dist. from the Node.			
N	D.	H.	M.	S.	s	°	′	″	s	°	′	″	s	°	′	″
1	29	12	44	3	0	29	6	19	0	25	49	0	1	0	40	14
2	39	1	28	6	1	28	12	39	1	21	38	1	2	1	20	28
3	88	14	12	9	2	27	18	58	2	17	27	1	3	2	0	42
4	118	2	56	12	3	26	25	17	3	13	16	2	4	2	40	56
5	147	15	40	15	4	25	31	37	4	9	5	2	5	3	21	10
6	177	4	24	18	5	24	37	56	5	4	54	3	6	4	1	24
7	206	17	8	21	6	23	44	15	6	0	43	3	7	4	41	38
8	236	5	52	24	7	22	50	35	6	26	32	3	8	5	21	52
9	265	18	36	27	8	21	56	54	7	22	21	4	9	6	2	6
10	295	7	20	30	9	21	3	14	8	18	10	4	10	6	42	20
11	324	20	4	33	10	20	9	33	9	13	59	5	11	7	22	34
12	354	8	48	36	11	19	15	55	10	9	48	5	0	8	2	47
13	383	21	32	40	0	18	22	12	11	5	37	6	1	8	43	1
½	14	18	22	2	0	14	33	10	6	12	54	30	0	15	20	7

TABLE IV. *The Days of the Year, reckoned from the beginning of March.*

Days	Mar.	Apr.	May	June	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.
1	1	32	62	93	123	154	185	215	246	276	307	338
2	2	33	63	94	124	155	186	216	247	277	308	339
3	3	34	64	95	125	156	187	217	248	278	309	340
4	4	35	65	96	126	157	188	218	249	279	310	341
5	5	36	66	97	127	158	189	219	250	280	311	342
6	6	37	67	98	128	159	190	220	251	281	312	343
7	7	38	68	99	129	160	191	221	252	282	313	344
8	8	39	69	100	130	161	192	222	253	283	314	345
9	9	40	70	101	131	162	193	223	254	284	315	346
10	10	41	71	102	132	163	194	224	255	285	316	347
11	11	42	72	103	133	164	195	225	256	286	317	348
12	12	43	73	104	134	165	196	226	257	287	318	349
13	13	44	74	105	135	166	197	227	258	288	319	350
14	14	45	75	106	136	167	198	228	259	289	320	351
15	15	46	76	107	137	168	199	229	260	290	321	352
16	16	47	77	108	138	169	200	230	261	291	322	353
17	17	48	78	109	139	170	201	231	262	292	323	354
18	18	49	79	110	140	171	202	232	263	293	324	355
19	19	50	80	111	141	172	203	233	264	294	325	356
20	20	51	81	112	142	173	204	234	265	295	326	357
21	21	52	82	113	143	174	205	235	266	296	327	358
22	22	53	83	114	144	175	206	236	267	297	328	359
23	23	54	84	115	145	176	207	237	268	298	329	360
24	24	55	85	116	146	177	208	238	269	299	330	361
25	25	56	86	117	147	178	209	239	270	300	331	362
26	26	57	87	118	148	179	210	240	271	301	332	363
27	27	58	88	119	149	180	211	241	272	302	333	364
28	28	59	89	120	150	181	212	242	273	303	334	365
29	29	60	90	121	151	182	213	243	274	304	335	366
30	30	61	91	122	152	183	214	244	275	305	336	
31	31		92		153	184		245		306	337	

TABLE V. *Mean Lunations from* 1 *to* 100000.

Lunat.	Days. Decimal Parts.		Days.	H.	M.	S.	Th.	Fo.
1	29.530590851080	=	29	12	44	3	2	58
2	59.061181702160		59	1	28	6	5	57
3	88.591772553240		88	14	12	9	8	55
4	118.122363404320		118	2	56	12	11	53
5	147.652954255401		147	15	40	15	14	52
6	177.183545106481		177	4	24	18	17	50
7	206.714135957561		206	17	8	21	20	48
8	236.244726808641		236	5	52	24	23	47
9	265.775317659722		265	18	36	27	26	45
10	295.305908851080		295	7	20	30	29	43
20	590.611817702160		590	14	41	0	59	26
30	885.917772553240		885	22	1	31	29	10
40	1181.22363404320		1181	5	22	1	58	53
50	1476.52954255401		1476	12	42	32	28	36
60	1771.83545106481		1771	20	3	2	58	19
70	2067.14135957561		2067	3	23	33	28	2
80	2362.44726808641		2362	10	44	3	57	46
90	2657.75317659722		2657	18	4	34	27	29
100	2953.0590851080		2953	1	25	4	57	12
200	5906.1181702160		5906	2	50	9	54	24
300	8859.1772553240		8859	4	15	14	51	36
400	11812.2363404320		11812	5	40	19	48	48
500	14765.2954255401		14765	7	5	24	46	0
600	17718.3545106481		17718	8	30	29	43	12
700	20671.4135957561		20671	9	55	34	40	24
800	23624.4726808641		23624	11	20	39	37	36
900	26577.5317659722		26577	12	45	44	34	48
1000	29530.590851080		29530	14	10	49	32	0
2000	59061.181702160		59061	4	21	39	4	0
3000	88591.772553240		88591	18	32	28	36	0
4000	118122.363404320		118122	8	43	18	8	0
5000	147652.954255401		147652	22	54	7	40	0
6000	177183.545106481		177183	13	4	57	12	0
7000	206714.135957561		206714	3	15	46	44	0
8000	236244.726808641		236244	17	26	36	16	0
9000	265775.317659722		265775	7	37	25	48	0
10000	295305.90851080		295305	21	48	15	20	0
20000	590611.81702160		590611	19	36	30	40	0
30000	885917.72553240		885917	17	24	46	0	0
40000	1181223.63404320		1181223	15	13	1	20	0
50000	1476529.54255401		1476529	13	1	16	40	0
60000	1771835.45106481		1771835	10	49	32	0	0
70000	2067141.35957561		2067141	8	37	47	20	0
80000	2362447.26808641		2362447	6	25	2	40	0
90000	2657753.17659722		2657753	4	14	18	0	0
100000	2953059.0851080		2953059	2	2	33	20	0

TABLE VI. *The first mean New Moon, with the mean Anomalies of the Sun and Moon, and the Sun's mean Distance from the Ascending Node, next after complete Centuries of Julian Years.*

Lunations.	Julian Years.	First New Moon				Sun's mean Anomaly.			M.'s mean Anomaly.			Sun from Node.		
		D.	H.	M.	S.	s	°	'	s	°	'	s	°	'
1237	100	4	8	10	52	0	3	21	8	15	22	4	19	27
2474	200	8	16	21	44	0	6	42	5	0	44	9	8	55
3711	300	13	0	32	37	0	10	3	1	16	6	1	28	22
4948	400	17	8	43	29	0	13	24	10	1	28	6	17	49
6185	500	21	16	54	21	0	16	46	6	16	50	11	7	16
7422	600	26	1	5	14	0	20	7	2	2	12	3	26	44
8658	700	0	20	32	3	11	24	22	10	21	45	7	15	31
9895	800	5	4	42	55	11	27	43	7	7	7	0	4	58
11132	900	9	12	53	47	0	1	4	3	22	29	4	24	25
12369	1000	13	21	4	40	0	4	25	0	7	51	9	13	53
13606	1100	18	5	15	32	0	7	46	8	23	13	2	3	20
14843	1200	22	13	26	24	0	11	7	5	8	35	6	22	47
16080	1300	26	21	37	16	0	14	28	1	23	57	11	12	15
17316	1400	1	17	4	6	11	18	43	9	13	30	3	1	2
18553	1500	6	1	14	58	11	22	4	5	28	52	7	20	29
19790	1600	10	9	25	50	11	25	25	2	14	14	0	9	56
21027	1700	14	17	36	42	11	28	46	10	29	36	4	29	23
22264	1800	19	1	47	35	0	2	8	7	14	58	9	18	51
23501	1900	23	9	58	27	0	5	29	4	0	20	2	8	18
24738	2000	27	18	9	19	0	8	50	0	15	42	6	27	45
25974	2100	2	13	36	8	11	13	5	8	5	15	10	16	32
27211	2200	6	21	47	1	11	16	26	4	20	37	3	6	0
28448	2300	11	5	57	53	11	19	47	1	5	59	7	25	27
29685	2400	15	14	8	45	11	23	8	9	21	21	0	14	54
30922	2500	19	22	19	38	11	26	29	6	6	43	5	4	22
32159	2600	24	6	30	30	11	29	50	2	22	4	9	23	49
33396	2700	28	14	41	22	0	3	11	11	7	26	2	13	16
34632	2800	3	10	8	11	11	7	26	6	26	59	6	2	3
35869	2900	7	18	19	3	11	10	47	3	12	21	10	21	30
37106	3000	12	2	29	56	11	14	8	11	27	43	3	10	58
38343	3100	16	10	40	48	11	17	30	8	13	5	8	0	25
39580	3200	20	18	51	40	11	20	51	4	28	27	0	19	52
40817	3300	25	3	2	33	11	24	12	1	13	49	5	9	20
42054	3400	29	11	13	25	11	27	33	9	29	11	9	28	47
43290	3500	4	6	40	14	11	1	48	5	18	44	1	17	34
44527	3600	8	14	51	6	11	5	9	2	4	6	6	7	1
45764	3700	12	23	1	59	11	8	30	10	19	28	10	26	29
47001	3800	17	7	12	51	11	11	51	7	4	50	3	15	56
48238	3900	21	15	23	43	11	15	12	3	20	12	8	5	23
49475	4000	25	23	34	35	11	18	33	0	5	34	0	24	50
50711	4100	0	19	1	25	10	22	48	7	25	7	4	13	37
51948	4200	5	3	12	17	10	26	9	4	10	29	9	3	5
53185	4300	9	11	23	9	10	29	31	0	25	51	1	22	32
54422	4400	13	19	34	1	11	2	52	9	11	13	6	11	59
55659	4500	18	3	44	54	11	6	13	5	26	35	11	1	27
56896	4600	22	11	55	46	11	9	34	2	11	57	3	20	54
58133	4700	26	20	6	38	11	12	55	10	27	19	8	10	21
59369	4800	1	15	33	27	10	17	9	6	16	52	11	29	8
60606	4900	5	23	44	20	10	20	31	3	2	14	4	18	36
61843	5000	10	7	55	12	10	23	52	11	17	36	9	8	3
63080	5100	14	16	6	4	10	27	13	8	2	58	1	27	30
64317	5200	19	0	16	56	11	0	34	4	18	20	6	16	57
65554	5300	23	8	27	49	11	3	55	1	3	42	11	6	25
66791	5400	27	16	38	41	11	7	16	9	19	4	2	25	52
68028	5500	2	12	5	30	10	11	31	5	8	37	7	14	39
69265	5600	6	20	16	22	10	14	52	1	23	59	0	4	6
70502	5700	11	4	27	15	10	18	14	10	9	21	4	23	34
71739	5800	15	12	38	7	10	21	35	6	24	43	9	13	1
72976	5900	19	20	48	59	10	24	56	3	10	5	2	2	28
74212	6000	24	4	59	52	10	28	17	11	25	27	6	21	56

TABLE VII. *The annual, or first Equation of the mean to the true Sizygy.*

Argument. Sun's mean Anomaly.

Subtract.

Degrees	0 Signs	1 Sign	2 Signs	3 Signs	4 Signs	5 Signs	Degrees
	H. M. S.	H. M. S.	H. M. S.	H. M. S.	H. M. S.	H. M. S.	
0	0 0 0	2 3 12	3 35 0	4 10 53	3 39 30	2 7 45	30
1	0 4 18	2 6 55	3 37 10	4 10 57	3 37 19	2 3 55	29
2	0 8 35	2 10 36	3 39 18	4 10 55	3 35 6	2 0 1	28
3	0 12 51	2 14 15	3 31 23	4 10 49	3 32 50	1 56 5	27
4	0 17 8	2 17 52	3 43 26	4 10 39	3 30 30	1 52 6	26
5	0 21 24	2 21 27	3 45 25	4 10 24	3 28 5	1 48 4	25
6	0 25 39	2 25 9	3 47 19	4 10 4	3 25 35	1 41 1	24
7	0 28 55	2 28 29	3 49 7	4 9 39	3 23 0	1 39 56	23
8	0 34 11	2 31 57	3 50 50	4 9 10	3 20 20	1 35 49	22
9	0 38 26	2 35 22	3 52 29	4 8 37	3 17 35	1 31 41	21
10	0 42 39	2 38 44	3 54 4	4 7 59	3 14 49	1 27 31	20
11	0 46 52	2 42 3	3 55 35	4 7 16	3 11 59	1 23 19	19
12	0 51 4	2 45 18	3 57 2	4 6 29	3 9 6	1 19 5	18
13	0 55 17	2 48 30	3 58 27	5 5 37	3 6 10	1 14 49	17
14	0 59 27	2 51 40	3 59 49	4 4 41	3 3 10	1 10 32	16
15	1 3 36	2 54 48	3 1 7	4 3 40	3 0 7	1 6 15	15
16	1 7 45	2 57 53	4 2 18	4 2 35	2 57 0	1 1 56	14
17	1 11 53	3 0 54	4 3 23	4 1 26	2 53 49	0 57 36	13
18	1 16 0	3 3 51	4 4 22	4 0 12	2 50 36	0 53 15	12
19	1 20 6	3 6 45	4 5 18	3 58 52	2 47 18	0 48 52	11
20	1 24 10	3 9 36	4 6 10	3 57 27	2 43 57	0 44 28	10
21	1 28 12	3 12 24	4 6 58	3 55 59	2 40 33	0 40 2	9
22	1 32 12	3 15 9	4 7 41	3 54 26	2 37 6	0 35 36	8
23	1 36 10	3 17 51	4 8 21	3 52 49	2 33 35	0 31 10	7
24	1 40 6	3 20 30	4 8 57	3 51 9	2 30 2	0 26 44	6
25	1 44 1	3 23 5	4 9 29	3 49 26	2 26 26	0 22 17	5
26	1 47 54	3 25 36	4 9 55	3 47 38	2 22 47	0 17 50	4
27	1 51 46	3 28 3	4 10 16	3 45 44	2 19 5	0 13 23	3
28	1 55 37	3 30 26	4 10 33	3 43 45	2 15 20	0 8 56	2
29	1 59 26	3 32 45	4 10 45	3 41 40	2 11 35	0 4 29	1
30	2 0 12	3 35 0	4 10 53	3 39 30	2 7 45	0 0 0	0
Deg.	11 Signs	10 Signs	9 Signs	8 Signs	7 Signs	6 Signs	Deg.

Add

TABLE VIII. *Equation of the Moon's mean Anomaly.*

Argument. Sun's mean Anomaly.

Subtract.

Degrees	0 Signs	1 Sign	2 Signs	3 Signs	4 Signs	5 Signs	Degrees
	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″	
0	0 0 0	0 46 45	1 21 32	1 35 1	1 23 4	0 48 19	30
1	0 1 37	0 48 10	1 22 21	1 35 2	1 22 14	0 46 51	29
2	0 3 13	0 49 34	1 23 10	1 35 1	1 21 24	0 45 23	28
3	0 4 52	0 50 53	1 23 57	1 35 0	1 20 32	0 43 54	27
4	0 6 28	0 52 19	1 24 41	1 34 57	1 19 38	0 42 24	26
5	0 8 6	0 53 40	1 25 24	1 34 50	1 18 42	0 40 53	25
6	0 9 42	0 55 0	1 26 6	1 34 43	1 17 45	0 39 21	24
7	0 11 20	0 56 21	1 26 48	1 34 33	1 16 48	0 37 49	23
8	0 12 56	0 57 38	1 27 28	1 34 22	1 15 47	0 36 15	22
9	0 14 33	0 58 56	1 28 6	1 34 9	1 14 44	0 34 40	21
10	0 16 10	1 0 13	1 28 43	1 33 53	1 13 41	0 33 5	20
11	0 17 47	1 1 29	1 29 17	1 33 37	1 12 37	0 31 31	19
12	0 19 23	1 2 43	1 29 51	1 33 20	1 11 33	0 29 54	18
13	0 20 59	1 3 56	1 30 22	1 33 0	1 10 26	0 28 18	17
14	0 22 35	1 5 8	1 30 50	1 32 38	1 9 17	0 26 40	16
15	0 24 10	1 6 18	1 31 19	1 32 14	1 8 8	0 25 3	15
16	0 25 45	1 7 27	1 31 45	1 31 50	1 6 58	0 23 23	14
17	0 27 19	1 8 36	1 32 12	1 31 23	1 5 46	0 21 45	13
18	0 28 52	1 9 42	1 32 34	1 30 55	1 4 32	0 20 7	12
19	0 30 25	1 10 49	1 32 57	1 30 25	1 3 19	0 18 28	11
20	0 31 57	1 11 54	1 33 17	1 29 54	1 2 1	0 16 48	10
21	0 33 29	1 12 58	1 33 36	1 29 20	1 0 45	0 15	9
22	0 35 2	1 14 1	1 33 52	1 28 45	0 59 26	0 13 28	8
23	0 36 32	1 15 1	1 34 6	1 28 9	0 58 7	0 11 48	7
24	0 38 1	1 16 0	1 34 18	1 27 30	0 56 45	0 10 7	6
25	0 39 29	1 16 59	1 34 30	1 26 50	0 55 23	0 8 20	5
26	0 40 59	1 17 57	1 34 40	1 26 27	0 54 1	0 6 44	4
27	0 42 26	1 18 52	1 34 48	1 25 5	0 52 37	0 5 3	3
28	0 43 54	1 19 47	1 34 54	1 24 39	0 51 12	0 3 21	2
29	0 45 19	1 20 40	1 34 58	1 23 52	0 49 45	0 1 40	1
30	0 46 45	1 21 32	1 35 1	1 23 4	0 48 19	0 0 0	0
Deg.	11 Signs	10 Signs	9 Signs	8 Signs	7 Signs	6 Signs	Deg.

Add

TABLE IX. *The second Equation of the mean to the true Sizygy*

Argument. Moon's equated Anomaly.

Add

Degrees	0 Signs	1 Sign	2 Signs	3 Signs	4 Signs	5 Signs	Degrees
	H. M. S.	H. M. S.	H. M. S.	H. M. S.	H. M. S.	H. M. S.	
0	0 0 0	5 12 48	8 47 8	9 46 44	8 8 59	4 34 33	30
1	0 10 58	5 21 56	8 51 45	9 45 3	8 3 12	4 26 1	29
2	0 21 56	5 30 57	8 56 10	9 45 12	7 57 23	4 17 25	28
3	0 32 54	5 39 51	9 0 25	9 44 11	7 51 33	4 8 47	27
4	0 43 52	5 48 37	9 4 31	9 42 59	7 45 46	4 0 7	26
5	0 54 50	5 57 17	9 8 25	9 41 36	7 39 46	3 51 23	25
6	1 5 48	6 5 51	9 12 9	9 40 3	7 33 36	3 42 32	24
7	1 16 46	6 14 19	9 15 43	9 38 19	7 27 22	3 33 38	23
8	1 27 44	6 22 41	9 19 5	9 36 24	7 21 2	3 24 42	22
9	1 38 40	6 30 57	9 22 14	9 34 18	7 14 30	3 15 44	21
10	1 49 33	6 39 4	9 25 12	9 32 1	7 7 50	3 6 45	20
11	2 0 23	6 47 0	9 27 54	9 29 33	7 1 2	2 57 43	19
12	2 11 10	6 54 46	9 30 32	9 26 54	6 54 8	2 48 39	18
13	2 21 54	7 2 24	9 32 58	9 24 4	6 47 9	2 39 34	17
14	2 32 34	7 9 52	9 35 14	9 21 3	6 40 6	2 30 28	16
15	2 43 9	7 17 9	9 37 12	9 17 51	6 32 56	2 21 19	15

TABLE IX. *Concluded.*

Degrees	0 Signs H.	M.	S.	1 Sign H.	M.	S.	2 Signs H.	M.	S.	3 Signs H.	M.	S.	4 Signs H.	M.	S.	5 Signs H.	M.	S.	Degrees
0	0	0	0	5	12	48	8	47	8	9	46	44	8	8	59	4	34	33	30
16	2	53	38	7	24	19	9	39	8	9	14	28	6	25	40	2	12	8	14
17	3	4	3	7	31	18	9	40	51	9	10	54	6	18	18	2	2	53	13
18	3	14	24	7	38	9	9	42	21	9	7	9	6	10	49	1	53	36	12
19	3	24	42	7	44	51	9	43	42	9	3	13	6	3	16	1	44	16	11
20	3	34	58	7	51	24	9	44	53	8	59	6	5	55	38	1	34	54	10
21	3	45	11	7	57	45	9	45	52	8	54	50	5	47	54	1	25	31	9
22	3	55	21	8	3	56	9	46	38	8	50	24	5	40	4	1	16	7	8
23	4	5	26	8	9	57	9	47	13	8	45	48	5	32	9	1	6	41	7
24	4	15	26	8	15	46	9	47	36	8	41	2	5	24	9	0	57	13	6
25	4	25	20	8	21	24	9	47	49	8	36	6	5	16	5	0	47	44	5
26	4	35	6	8	26	53	9	47	54	8	31	0	5	7	56	0	38	13	4
27	4	44	42	8	32	11	9	47	46	8	25	44	4	59	42	0	28	41	3
28	4	54	11	8	37	19	9	47	33	8	20	18	4	51	15	0	19	8	2
29	5	3	33	8	42	18	9	47	14	8	14	33	4	43	2	0	9	34	1
30	5	12	48	8	47	8	9	46	44	8	8	59	4	34	33	0	0	0	0
Deg.	11 Signs			10 Signs			9 Signs			8 Signs			7 Signs			6 Signs			Deg.

TABLE X. *The third equation of the mean to the true Syzygy.*

Argument. Sun's Anomaly—Moon's Anomaly.

Degrees	Signs 0 Sub. 6 Add M.	S.	Signs 1 Sub. 7 Add M.	S.	Signs 2 Sub. 8 Add M.	S.	Degrees
0	0	0	2	22	4	12	30
1	0	5	2	26	4	15	29
2	0	10	2	30	4	18	28
3	0	15	2	34	4	21	27
4	0	20	2	38	4	24	26
5	0	25	2	42	4	27	25
6	0	30	2	46	4	30	24
7	0	35	2	50	4	32	23
8	0	40	2	54	4	34	22
9	0	45	2	58	4	36	21
10	0	50	3	2	4	38	20
11	0	55	3	6	4	40	19
12	1	0	3	10	4	42	18
13	1	5	3	14	4	44	17
14	1	10	3	18	4	46	16
15	1	15	3	22	4	48	15
16	1	20	3	26	4	50	14
17	1	25	3	30	4	51	13
18	1	30	3	34	4	52	12
19	1	35	3	38	4	53	11
20	1	40	3	42	4	54	10
21	1	45	3	45	4	55	9
22	1	49	3	48	4	56	8
23	1	52	3	51	4	57	7
24	1	56	3	54	4	57	6
25	2	0	3	57	4	57	5
26	2	4	4	0	4	58	4
27	2	9	4	3	4	58	3
28	2	13	4	6	4	58	2
29	2	18	4	9	4	58	1
30	2	22	4	12	4	58	0
Degrees	Signs 5 Sub. 11 Add		Signs 4 Sub. 10 Add		Signs 3 Sub. 9 Add		Degrees

TAB. XI. *The fourth equation of the mean to the true Syzygy.*

Argument. Sun's mean distance from the Node.

Degrees	Add: 0, 6 Sig. M.	S.	1, 7 Sig. M.	S.	2, 8 Sig. M.	S.	Degrees
0	0	0	1	22	1	22	30
1	0	4	1	23	1	21	29
2	0	7	1	24	1	20	28
3	0	10	1	25	1	18	27
4	0	13	1	26	1	16	26
5	0	16	1	27	1	14	25
6	0	20	1	28	1	12	24
7	0	23	1	29	1	10	23
8	0	26	1	30	1	8	22
9	0	29	1	31	1	6	21
10	0	32	1	32	1	3	20
11	0	35	1	33	1	0	19
12	0	38	1	33	0	57	18
13	0	41	1	34	0	54	17
14	0	44	1	34	0	51	16
15	0	47	1	34	0	49	15
16	0	50	1	34	0	45	14
17	0	52	1	34	0	41	13
18	0	54	1	34	0	37	12
19	0	57	1	33	0	34	11
20	1	0	1	33	0	31	10
21	1	2	1	32	0	28	9
22	1	5	1	31	0	25	8
23	1	8	1	30	0	22	7
24	1	10	1	29	0	19	6
25	1	12	1	28	0	16	5
26	1	14	1	27	0	13	4
27	1	16	1	26	0	10	3
28	1	18	1	25	0	6	2
29	1	20	1	24	0	3	1
30	1	22	1	22	0	0	0
Deg.	Subtract: 5, 11 Sig.		4, 10 Sig.		3, 9 Sig.		Deg.

TABLE XII. *The Sun's mean Longitude, Motion, and Anomaly, Old Style.*

Years beginning	Sun's mean Longitude s	°	′	″	Sun's mean Anomaly s	°	′
1	9	7	53	10	6	28	48
201	9	9	23	50	6	26	57
301	9	10	9	10	6	26	1
401	9	10	54	30	6	25	5
501	9	11	39	50	6	24	9
1001	9	15	26	30	6	19	32
1101	9	16	11	50	6	18	36
1201	9	16	57	10	6	17	40
1301	9	17	42	30	6	16	44
1401	9	18	27	50	6	15	49
1501	9	19	13	10	6	14	53
1601	9	19	58	30	6	13	57
1701	9	20	43	50	6	13	1
1801	9	21	29	10	6	12	6

Years complete	Sun's mean Motion s	°	′	″	Sun's mean Anomaly s	°	′
1	11	29	45	40	11	29	45
2	11	29	31	20	11	29	29
3	11	29	17	0	11	29	14
4	0	0	1	49	11	29	58
5	11	29	47	29	11	29	42
6	11	29	33	9	11	29	27
7	11	29	18	49	11	29	11
8	0	0	3	38	11	29	55
9	11	29	49	18	11	29	40
10	11	29	34	58	11	29	24
11	11	29	20	38	11	29	9
12	0	0	5	26	11	29	53
13	11	29	51	7	11	29	37
14	11	29	36	47	11	29	22
15	11	29	22	25	11	29	7
16	0	0	7	15	11	29	50
17	11	29	52	55	11	29	35
18	11	29	38	35	11	29	20

Years complete	Sun's mean Motion s	°	′	″	Sun's mean Anomaly s	°	′
19	10	29	24	16	11	29	4
20	0	0	9	4	11	29	48
40	0	0	18	8	11	29	37
60	0	0	27	12	11	29	26
80	0	0	36	16	11	29	15
100	0	0	45	20	11	29	4
200	0	1	30	40	11	28	8
300	0	2	16	0	11	27	12
400	0	3	1	20	11	26	16
500	0	3	46	40	11	25	21
600	0	4	32	0	11	24	25
700	0	5	17	20	11	23	29
800	0	6	2	40	11	22	33
900	0	6	48	0	11	21	37
1000	0	7	33	20	11	20	41
2000	0	15	6	40	11	11	22
3000	0	22	40	0	11	2	3
4000	1	0	13	20	10	22	44
5000	1	7	46	40	10	13	25
6000	1	15	20	0	10	4	6

Months	Sun's mean Motion s	°	′	″	Sun's mean Anomaly s	°	′
Jan.	0	0	0	0	0	0	0
Feb.	1	0	33	18	1	0	33
Mar	1	28	9	11	1	28	9
Apr.	2	28	42	30	2	28	42
May	3	28	16	40	3	28	17
June	4	28	49	50	4	28	50
July	5	28	24	8	5	28	24
Aug.	6	28	57	26	6	28	57
Sept.	7	29	30	44	7	29	30
Oct.	8	29	4	54	8	29	4
Nov.	9	29	38	12	9	29	37
Dec.	10	29	12	22	10	29	11

Days	Sun's mean Motion and Anomaly s	°	′	″	H M S	Sun's mean Motion and Anomaly ° ′ ″	′ ″ ‴	″ ‴ ⁗	Sun's mean dist. from the Node ° ′ ″	′ ″ ‴	″ ‴ ⁗	H M S	Sun's mean Motion and Anomaly ° ′ ″	′ ″ ‴	″ ‴ ⁗	Sun's mean dist. from the Node ° ′ ″	′ ″ ‴	″ ‴ ⁗
1	0	0	59	8														
2	0	1	58	17	1	0	2	28	0	2	36	31	1	16	23	1	20	30
3	0	2	57	25	2	0	4	56	0	5	12	32	1	18	51	1	23	6
4	0	3	56	33	3	0	7	24	0	7	48	33	1	21	19	1	25	42
5	0	4	55	42	4	0	9	51	0	10	39	34	1	23	57	1	28	18
6	0	5	54	50	5	0	12	19	0	12	59	35	1	26	15	1	30	54
7	0	6	53	58	6	0	14	47	0	15	35	36	1	28	42	1	33	29
8	0	7	53	7	7	0	17	15	0	18	11	37	1	31	10	1	36	5
9	0	8	52	15	8	0	19	43	0	20	47	38	1	33	38	1	38	40
10	0	9	51	23	9	0	22	11	0	23	23	39	1	36	6	1	41	16
11	0	10	50	32	10	0	24	38	0	25	58	40	1	38	34	1	43	52
12	0	11	49	40	11	0	27	6	0	28	34	41	1	41	2	1	46	28
13	0	12	48	48	12	0	29	34	0	31	10	42	1	43	30	1	49	4
14	0	13	47	57	13	0	32	2	0	33	45	43	1	45	57	1	51	39
15	0	14	47	5	14	0	34	30	0	36	21	44	1	48	25	1	54	15
16	0	15	46	13	15	0	36	58	0	38	57	45	1	50	53	1	55	51
17	0	16	45	22	16	0	39	26	0	41	33	46	1	53	21	1	59	27
18	0	17	44	30	17	0	41	53	0	44	8	47	1	55	49	2	2	3
19	0	18	43	38	18	0	44	21	0	46	44	48	1	58	17	2	4	39
20	0	19	42	47	19	0	46	49	0	49	20	49	2	0	44	2	7	13
21	0	20	41	55	20	0	49	17	0	51	56	50	2	3	12	2	9	50
22	0	21	41	3	21	0	51	45	0	54	32	51	2	5	40	2	12	25
23	0	22	40	12	22	0	54	13	0	57	8	52	2	8	8	2	15	2
24	0	23	39	20	23	0	56	40	0	59	43	53	2	10	36	2	17	38
25	0	24	38	28	24	0	59	8	1	2	19	54	2	13	4	2	20	14
26	0	25	37	45	25	1	1	36	1	4	55	55	2	15	32	2	22	50
27	0	26	36	37	26	1	4	4	1	7	31	56	2	17	59	2	25	26
28	0	27	35	53	27	1	6	32	1	10	7	57	2	20	27	2	28	2
29	0	28	35	2	28	1	9	0	1	12	43	58	2	22	55	2	30	38
30	0	29	34	10	29	1	11	28	1	15	19	59	2	25	23	2	33	14
31	1	0	33	18	30	1	13	55	1	17	45	60	2	27	51	2	35	50

In Leap years, after February, add one day, and one day's motion.

TABLE XIII. *Equation of the Sun's centre, or the difference between his mean and true place.*

Argument. Sun's mean Anomaly.

Subtract

Degrees	0 Signs ° ' "	1 Sign ° ' "	2 Signs ° ' "	3 Signs ° ' "	4 Signs ° ' "	5 Signs ° ' "	Degrees
0	0 0 0	0 56 47	1 39 6	1 55 37	1 41 12	0 58 33	30
1	0 1 59	0 58 30	1 40 7	1 55 39	1 40 12	0 57 7	29
2	0 3 57	1 0 12	1 41 6	1 55 38	1 39 10	0 55 19	28
3	0 5 56	1 1 53	1 42 3	1 55 36	1 38 6	0 53 30	27
4	0 7 54	1 3 33	1 42 59	1 55 31	1 37 0	0 51 40	26
5	0 9 52	1 5 12	1 43 52	1 55 24	1 35 52	0 49 49	25
6	0 11 50	1 6 50	1 44 44	1 55 15	1 34 43	0 47 57	24
7	0 13 48	1 8 27	1 45 34	1 55 3	1 33 32	0 46 5	23
8	0 15 46	1 10 2	1 46 22	1 54 50	1 32 19	0 44 11	22
9	0 17 43	1 11 36	1 47 8	1 54 35	1 31 4	0 42 16	21
10	0 19 40	1 13 9	1 47 53	1 54 17	1 29 47	0 40 21	20
11	0 21 37	1 14 41	1 48 35	1 53 57	1 28 29	0 38 25	19
12	0 23 33	1 16 11	1 49 15	1 53 36	1 27 9	0 36 28	18
13	0 25 29	1 17 40	1 49 54	1 53 12	1 25 48	0 34 30	17
14	0 27 25	1 19 8	1 50 30	1 52 46	1 24 25	0 32 32	16
15	0 29 20	1 20 34	1 51 5	1 52 18	1 23 0	0 30 33	15
16	0 31 15	1 21 59	1 51 37	1 51 48	1 21 34	0 28 33	14
17	0 33 9	1 23 22	1 52 8	1 51 15	1 20 6	0 26 33	13
18	0 35 2	1 24 44	1 52 36	1 50 41	1 18 36	0 24 33	12
19	0 36 55	1 26 5	1 53 3	1 50 5	1 17 5	0 22 32	11
20	0 38 47	1 27 24	1 53 27	1 49 26	1 15 33	0 20 30	10
21	0 40 39	1 28 41	1 53 50	1 48 46	1 13 59	0 18 28	9
22	0 42 30	1 29 57	1 54 10	1 48 3	1 12 24	0 16 26	8
23	0 44 20	1 31 11	1 54 28	1 47 19	1 10 47	0 14 24	7
24	0 46 9	1 32 25	1 54 44	1 46 32	1 9 9	0 12 21	6
25	0 47 57	1 33 35	1 54 58	1 45 44	1 7 29	0 10 18	5
26	0 49 45	1 34 45	1 55 10	1 44 53	1 5 49	0 8 14	4
27	0 51 32	1 35 53	1 55 20	1 44 1	1 4 7	0 6 11	3
28	0 53 18	1 36 59	1 55 28	1 43 7	1 2 24	0 4 7	2
29	0 55 3	1 38 3	1 55 34	1 42 10	1 0 39	0 2 4	1
30	0 56 47	1 39 6	1 55 37	1 41 12	0 58 53	0 0 0	0
Deg.	11 Signs	10 Signs	9 Signs	8 Signs	7 Signs	6 Signs	Deg.

Add

TABLE XIV. *The Sun's Declination.*

Argument. Sun's true place.

Degrees	Signs 0 N. 6 S. ° '	Signs 1 N. 7 S. ° '	Signs 2 N. 8 S. ° '	Degrees	Degrees	Signs 0 N. 6 S. ° '	Signs 1 N. 7 S. ° '	Signs 2 N. 8 S. ° '	Degrees
0	0 0	11 30	20 11	30	0	0 0	11 30	20 11	30
1	0 24	11 51	20 24	29	16	6 18	16 39	22 46	14
2	0 48	12 11	20 36	28	17	6 41	16 57	22 51	13
3	1 12	12 32	20 48	27	18	7 4	17 14	22 56	12
4	1 36	12 53	20 59	26	19	7 27	17 30	23 2	11
5	1 59	13 13	21 10	25	20	7 50	17 46	23 6	10
6	2 23	13 33	21 21	24	21	8 13	18 2	23 11	9
7	2 47	13 53	21 31	23	22	8 35	18 18	23 14	8
8	3 11	14 12	21 41	22	23	9 57	18 33	23 18	7
9	3 34	14 31	21 50	21	24	9 20	18 48	23 21	6
10	3 58	14 50	21 59	20	25	9 42	19 3	23 23	5
11	4 22	15 9	22 8	19	26	10 4	19 17	23 25	4
12	4 45	15 28	22 16	18	27	10 25	19 31	23 27	3
13	5 9	15 46	22 24	17	28	10 47	19 45	23 28	2
14	5 32	16 4	22 31	16	29	11 8	19 58	23 29	1
15	5 5	16 22	22 38	15	30	11 30	20 11	23 29	0
Degrees	Signs 11 S. 5 N.	Signs 10 S. 4 N.	Signs 9 S. 3 N.	Degrees	Degrees	Signs 11 S. 5 N.	Signs 10 S. 4 N.	Signs 9 S. 3 N.	Degrees

TABLE XV. *Equation of the Sun's mean Distance from the Node.*

Argument. Sun's mean Anomaly.

Subtract.

Deg.	0 Signs ° '	1 Sign ° '	2 Signs ° '	3 Signs ° '	4 Signs ° '	5 Signs ° '	Deg.
0	0 0	1 2	1 47	2 5	1 50	1 4	30
1	0 2	1 4	1 48	2 5	1 48	1 2	29
2	0 4	1 6	1 49	2 5	1 47	1 0	28
3	0 6	1 8	1 50	2 5	1 46	0 58	27
4	0 9	1 10	1 51	2 5	1 45	0 56	26
5	0 11	1 12	1 52	2 5	1 44	0 54	25
6	0 13	1 14	1 53	2 5	1 43	0 52	24
7	0 15	1 16	1 54	2 4	1 41	0 50	23
8	0 17	1 17	1 55	2 4	1 40	0 48	22
9	0 19	1 18	1 56	2 4	1 39	0 46	21
10	0 21	1 19	1 57	2 4	1 37	0 44	20
11	0 23	1 21	1 58	2 3	1 36	0 42	19
12	0 25	1 22	1 58	2 3	1 34	0 40	18
13	0 28	1 24	1 59	2 3	1 33	0 37	17
14	0 30	1 26	2 0	2 2	1 31	0 35	16
15	0 32	1 27	2 0	2 2	1 30	0 33	15
Deg.	11 Signs	10 Signs	9 Signs	8 Signs	7 Signs	6 Signs	Deg.

Deg.	0 Signs ° '	1 Sign ° '	2 Signs ° '	3 Signs ° '	4 Signs ° '	5 Signs ° '	Deg.
0	0 0	1 2	1 47	2 5	1 50	1 4	30
16	0 34	1 28	2 1	2 1	1 28	0 31	14
17	0 36	1 30	2 1	2 1	1 27	0 29	13
18	0 38	1 31	2 2	2 0	1 25	0 27	12
19	0 40	1 34	2 2	2 0	1 24	0 24	11
20	0 42	1 35	2 3	1 59	1 23	0 22	10
21	0 44	1 36	2 3	1 59	1 21	0 20	9
22	0 46	1 37	2 4	1 58	1 19	0 18	8
23	0 48	1 39	2 4	1 57	1 17	0 16	7
24	0 50	1 40	2 4	1 56	1 15	0 13	6
25	0 52	1 41	2 4	1 55	1 13	0 11	5
26	0 54	1 43	2 5	1 54	1 11	0 9	4
27	0 56	1 44	2 5	1 53	1 9	0 7	3
28	0 58	1 45	2 5	1 52	1 8	0 5	2
29	1 0	1 46	2 5	1 51	1 6	0 3	1
30	1 2	1 47	2 5	1 50	1 4	0 0	0
Deg.	11 Sign	10 Signs	9 Signs	8 Signs	7 Signs	6 Signs	Deg.

Add

TABLE XVI.

The Moon's Latitude in Eclipses.

Arg. Moon's equated Distance from the Node.

0 Signs. *North Ascend.*

6 Signs. *South Descend.*

°	° ' "	°
0	0 0 0	30
1	0 5 15	29
2	0 10 30	28
3	0 15 45	27
4	0 20 59	26
5	0 26 13	25
6	0 31 26	24
7	0 36 39	23
8	0 41 51	22
9	0 47 2	21
10	0 52 13	20
11	0 57 23	19
12	1 2 31	18
13	1 7 38	17
14	1 12 44	16
15	1 17 49	15
16	1 22 52	14
17	1 27 53	13
18	1 32 52	12
19	1 37 49	11

5 Signs. *North Descend.*

11 Signs. *South Ascend.*

This Table shows the Moon's Latitude a little beyond the utmost Limits of Eclipses.

TABLE XVII. *The Moon's horizontal Parallax, with the Semidiameters and true Horary Motions of the Sun and Moon, to every sixth degree of their mean Anomalies, the quantities for the intermediate degrees being easily proportioned by sight.*

Anomaly of Sun and Moon. s °	Moon's horizontal Parallax. ' "	Sun's Semidiameter. ' "	Moon's Semidiameter. ' "	Moon's Horary Motion. ' "	Sun's Horary Motion. ' "	Anomaly of Sun and Moon. s °
0 0	54 29	15 50	14 54	30 10	2 23	12 0
6	54 31	15 50	14 55	30 12	2 23	24
12	54 34	15 50	14 56	30 15	2 23	18
18	54 40	15 51	14 57	30 19	2 23	12
24	54 47	15 51	14 58	30 26	2 23	6
1 0	54 56	15 52	14 59	30 34	2 24	11 0
6	55 6	15 53	15 1	30 44	2 24	24
12	55 17	15 54	15 4	30 55	2 24	18
18	55 29	15 55	15 8	31 9	2 24	12
24	55 42	15 56	15 12	31 23	2 25	6
2 0	55 56	15 58	15 17	31 40	2 25	10 0
6	56 12	15 59	15 22	31 56	2 26	24
12	56 29	16 1	15 26	32 17	2 27	18
18	56 48	16 2	15 30	32 39	2 27	12
24	57 8	16 4	15 36	33 11	2 28	6
3 0	57 30	16 6	15 41	33 23	2 28	9 0
6	57 52	16 8	15 46	33 47	2 29	24
12	58 12	16 10	15 52	34 11	2 29	18
18	58 31	16 11	15 58	34 34	2 29	12
24	58 49	16 13	16 3	34 58	2 30	6
4 0	59 6	16 14	16 9	35 22	2 30	8 0
6	59 21	16 15	16 14	35 45	2 31	24
12	59 35	16 17	16 19	36 0	2 31	18
18	59 48	16 19	16 24	36 20	2 32	12
24	60 0	16 20	16 28	36 40	2 32	6
5 0	60 11	16 21	16 31	37 0	2 32	7 0
6	60 21	16 21	16 32	37 10	2 33	24
12	60 30	16 22	16 37	37 19	2 33	18
18	60 38	16 22	16 38	37 28	2 33	12
24	60 45	16 23	16 39	37 36	2 33	6
6 0	60 45	16 23	16 39	37 40	2 33	6 0

Description of Astronomical Instruments.

II. *Description of Astronomical Instruments serving to illustrate the Motions of the Heavenly Bodies.*

357 The orrery. THE machine represented by fig. 161. is the GRAND ORRERY, first made in this kingdom by Mr Rowley for King George I. The frame of it, which contains the wheel-work, &c. and regulates the whole machine, is made of ebony, and about four feet in diameter; the outside thereof is adorned with 12 pilasters. Between these the 12 signs of the zodiac are neatly painted with gilded frames. Above the frame is a broad ring supported with 12 pillars. This ring represents the plane of the ecliptic; upon which are two circles of degrees, and between these the names and characters of the 12 signs. Near the outside is a circle of months and days, exactly corresponding to the sun's place at noon each day throughout the year. Above the ecliptic stand some of the principal circles of the sphere, agreeable to their respective situations in the heavens: viz. N° 10. are the two colures, divided into degrees and half degrees; N° 11. is one-half the equinoctial circle, making an angle of $23\frac{1}{2}$ degrees. The tropic of Cancer and the arctic circle are each fixed parallel at their proper distance from the equinoctial. On the northern half of the ecliptic is a brass semicircle, moveable upon two points fixed in ♈ and ♎. This semicircle serves as a moveable horizon to be put to any degree of latitude upon the north part of the meridian, and the whole machine may be set to any latitude without disturbing any of the internal motions, by two strong hinges (N° 13.) fixed to the bottom-frame upon which the instrument moves, and a strong brass arch, having holes at every degree, through which a strong pin is put at every elevation. This arch and the two hinges support the whole machine when it is lifted up according to any latitude; and the arch at other times lies conveniently under the bottom-frame. When the machine is to be set to any latitude (which is easily done by two men, each taking hold of two handles conveniently fixed for the purpose), set the moveable horizon to the same degree upon the meridian, and hence you may form an idea of the respective altitude or depression of the planets both primary and secondary. The sun (N° 1.) stands in the middle of the whole system upon a wire, making an angle with the ecliptic of about 82 degrees. Next the sun is small ball (2.), representing Mercury. Next to Mercury is Venus (3.), represented by a larger ball. The earth is represented (N° 4.) by an ivory ball, having some circles and a map sketched upon it. The wire which supports the earth makes an angle with the ecliptic of $66\frac{1}{2}$ degrees, the inclination of the earth's axis to the ecliptic. Near the bottom of the earth's axis is a dial-plate (N° 9.), having an index pointing to the hours of the day as the earth turns round its axis. Round the earth is a ring supported by two small pillars, representing the orbit of the moon; and the divisions upon it answer to the moon's latitude. The motion of this ring represents the motion of the moon's orbit according to that of the nodes. Within this ring is the moon (N° 5.), having a black cap or case, by which its motion represents the phases of the moon according to her age. Without the orbits of the earth and moon is Mars (N° 6.) The next in order to Mars is Jupiter and his four moons (N° 7.) Each of these moons is supported by a wire fixed in a socket which turns about the pillar supporting Jupiter. These satellites may be turned by the hand to any position, and yet when the machine is put into motion, they will all move in their proper times. The outermost of all is Saturn, his five moons, and his ring (N° 8.) These moons are supported and contrived similar to those of Jupiter. The machine is put into motion by turning a small winch (N° 14.); and the whole system is also moved by this winch, and by pulling out and pushing in a small cylindrical pin above the handle. When it is pushed in, all the planets, both primary and secondary, will move according to their respective periods by turning the handle. When it is drawn out, the motions of the satellites of Jupiter and Saturn will be stopped while all the rest move without interruption. There is also a brass lamp, having two convex glasses to be put in room of the sun; and also a smaller earth and moon, made somewhat in proportion to their distance from each other, which may be put on at pleasure. The lamp turns round at the same time with the earth, and the glasses of it cast a strong light upon her; and when the smaller earth and moon are placed on, it will be easy to show when either of them will be eclipsed. When this machine is intended to be used, the planets must be duly placed by means of an ephemeris hereafter described; and you may place a small black patch or bit of wafer upon the middle of the sun. Right against the first degree of ♈, you may also place patches upon Venus, Mars, and Jupiter, right against some noted point in the ecliptic. Put in the handle, and push in the pin which is above it. One turn of this handle answers to a revolution of the ball which represents the earth about its axis; and consequently to 24 hours of time, as shown by the hour index (9.), which is marked and placed at the foot of the wire on which the ball of the earth is fixed. Again, when the index has moved the space of ten hours, Jupiter makes one revolution round its axis, and so of the rest. By these means the revolutions of the planets, and their motions round their own axes, will be represented to the eye. By observing the motions of the spots upon the surface of the sun and of the planets in the heavens, their diurnal rotation was first discovered, after the same manner as we in this machine observe the motions of their representatives by that of the marks placed upon them.

The ORRERY (fig. 162.) is a machine contrived by the late ingenious Mr James Fergusons. It shows the motions of the sun, Mercury, Venus, earth, and moon; and occasionally the superior planets, Mars, Jupiter, and Saturn, may be put on. Jupiter's four satellites are moved round him in their proper times by a small winch; and Saturn has his five satellites, and his ring which keeps its parallelism round the sun; and by a lamp put in the sun's place, the ring shows all its various phases already described.

In the centre, N° 1. represents the sun, supported by its axis, inclining almost 8 degrees from the axis of the ecliptic, and turning round in $25\frac{1}{4}$ days on its axis, of which the north pole inclines toward the eighth degree of Pisces in the great ecliptic (N° 11.), whereon the months and days are engraven over the signs and degrees in which the sun appears, as seen from the earth, on the different days of the year.

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Description of Astronomical Instruments.

The nearest planet (N° 2.) to the sun is Mercury, which goes round him in 87 days, 23 hours, or $87\frac{2}{24}$ diurnal rotations of the earth; but has no motion round its axis in the machine, because the time of its diurnal motion in the heavens is not known to us.

The next planet in order is Venus (N° 3.), which performs her annual course in 224 days 17 hours, and turns round her axis in 24 days 8 hours, or in $24\frac{1}{3}$ diurnal rotations of the earth. Her axis inclines 75 degrees from the axis of the ecliptic, and her north pole inclines towards the 20th degree of Aquarius, according to the observations of Bianchini. She shows all the phenomena described in Part II.

Next, without the orbit of Venus, is the earth (N° 4.), which turns round its axis, to any fixed point at a great distance, in 23 hours 56 minutes 4 seconds of mean solar time; but from the sun to the sun again, in 24 hours of the same time. N° 6. is a sidereal dial-plate under the earth, and N° 7. a solar dial-plate on the cover of the machine. The index of the former shows sidereal, and of the latter, solar time; and hence the former index gains one entire revolution on the latter every year, as 365 solar or natural days contain 366 sidereal days, or apparent revolutions of the stars. In the time that the earth makes $365\frac{1}{4}$ diurnal rotations on its axis, it goes once round the sun in the plane of the ecliptic; and always keeps opposite to a moving index (N° 10.) which shows the sun's daily change of place, and also the days of the months.

The earth is half covered with a black cap, for dividing the apparently enlightened half next the sun from the other half, which, when turned away from him, is in the dark. The edge of the cap represents the circle bounding light and darkness, and shows at what time the sun rises and sets to all places throughout the year. The earth's axis inclines $23\frac{1}{2}$ degrees from the axis of the ecliptic; the north pole inclines towards the beginning of Cancer, and keeps its parallelism throughout its annual course; so that in summer the northern parts of the earth incline towards the sun, and in winter from him: by which means, the different lengths of days and nights, and the cause of the various seasons, are demonstrated to sight.

There is a broad horizon, to the upper side of which is fixed a meridian semicircle in the north and south points, graduated on both sides from the horizon to 90° in the zenith or vertical point. The edge of the horizon is graduated from the east and west to the south and north points, and within these divisions are the points of the compass. From the lower side of this thin horizontal plate stand out four small wires, to which is fixed a twilight circle 18 degrees from the graduated side of the horizon all round. This horizon may be put upon the earth (when the cap is taken away), and rectified to the latitude of any place; and then by a small wire called the *solar ray*, which may be put on so as to proceed directly from the sun's centre towards the earth's, but to come no farther than almost to touch the horizon. The beginning of twilight, time of sunrising, with his amplitude, meridian altitude, time of setting, amplitude then, and end of twilight, are shown for every day of the year, at that place to which the horizon is rectified.

The moon (N° 5.) goes round the earth, from between it and any fixed point at a great distance, in 27 days 7 hours 43 minutes, or through all the signs and degrees of her orbit, which is called her *periodical revolution*; but she goes round from the sun to the sun again, or from change to change, in 29 days 12 hours 35 minutes, which is her *synodical revolution*; and in that time she exhibits all the phases already described.

When the above-mentioned horizon is rectified to the latitude of any given place, the times of the moon's rising and setting, together with her amplitude, are shown to that place as well as the sun's; and all the various phenomena of the harvest-moon are made obvious to sight.

The moon's orbit (N° 9.) is inclined to the ecliptic (N° 11.) one half being above, and the other below it. The nodes, or points at o and o, lie in the plane of the ecliptic, as before described, and shift backward through all its signs and degrees in $18\frac{2}{3}$ years. The degrees of the moon's latitude to the highest at NL (north latitude) and lowest at SL (south latitude), are engraven both ways from her nodes at o and o, and as the moon rises and falls in her orbit according to its inclination, her latitude and distance from her nodes are shown for every day, having first rectified her orbit so as to set the nodes to their proper places in the ecliptic; and then as they come about at different and almost opposite times of the year, and then point towards the sun, all the eclipses may be shown for hundreds of years (without any new rectification) by turning the machinery backward for time past, or forward for time to come. At 17 degrees distance from each node, on both sides, is engraved a small sun; and at 12 degrees distance, a small moon, which show the limits of solar and lunar eclipses; and when, at any change, the moon falls between either of these suns and the node, the sun will be eclipsed on the day pointed to by the annual index (N° 10.); and as the moon has then north or south latitude, one may easily judge whether that eclipse will be visible in the northern or southern hemisphere: especially as the earth's axis inclines toward the sun or from him at that time. And when at any full the moon falls between either of the little moons and node, she will be eclipsed, and the annual index shows the day of that eclipse. There is a circle of $29\frac{1}{2}$ equal parts (N° 8.) on the cover of the machine, on which an index shows the days of the moon's age.

There are two semicircles (fig. 163.) fixed to an elliptical ring, which being put like a cap upon the earth, and the forked part F upon the moon, shows the tides as the earth turns round within them, and they are led round it by the moon. When the different places come to the semicircle A*a*E*b*B, they have tides of flood; and when then come to the semicircle CED, they have tides of ebb; the index on the hour-circle (fig. 162.) showing the times of these phenomena.

There is a jointed wire, of which one end being put into a hole in the upright stem that holds the earth's cap, and the wire laid into a small forked piece which may be occasionally put upon Venus or Mercury, shows the direct and retrograde motions of these two planets, with their stationary times and places as seen from the earth.

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The whole machinery is turned by a winch or handle (N° 12.); and is so easily moved, that a clock might turn it without any danger of stopping.

To give a plate of the wheel-work of this machine would answer no purpose, because many of the wheels lie so behind others as to hide them from sight in any view whatever.

The Planetarium (fig. 164.) is an instrument contrived by Mr William Jones of Holborn, London, mathematical instrument maker, who has paid considerable attention to those sort of machines, in order to reduce them to their greatest degree of simplicity and perfection. It represents in a general manner, by various parts of its machinery, all the motions and phenomena of the planetary system. This machine consists of, the Sun (in the centre), with the planets, Mercury, Venus, the Earth and Moon, Mars, Jupiter and his four moons, Saturn and his five moons; and to it is occasionally applied an extra long arm for the Georgian planet and his two moons. To the earth and moon is applied a frame CD, containing only four wheels and two pinions, which serve to preserve the earth's axis in its proper parallelism in its motion round the sun, and to give the moon her due revolution about the earth at the same time. These wheels are connected with the wheel-work in the round box below, and the whole is set in motion by the winch H. The arm M that carries round the moon, points out on the plate C her age and phases for any situation in her orbit, and which accordingly are engraved thereon. In the same manner the arm points out her place in the ecliptic B, in signs and degrees, called her geocentric place; that is, as seen from the earth. The moon's orbit is represented by the flat rim A; the two joints of which, and upon which it turns, denoting her nodes. This orbit is made to incline to any desired angle. The earth of this instrument is usually made of a three inch or 1½ globe, papered, &c. for the purpose; and by means of the terminating wire that goes over it, points out the changes of the seasons, and the different lengths of days and nights more conspicuously. This machine is also made to represent the Ptolemaic System, or such as is vulgarly received; which places the earth in the centre, and the planets and sun revolving about it. (It is done by an auxiliary small sun and an earth, which change their places in the instrument.) At the same time, it affords a most manifest confutation of it: for it is plainly observed in this construction, (1.) That the planets Mercury and Venus, being both within the orbit of the sun, cannot at any time be seen to go behind it; whereas in nature we observe them as often to go behind as before the sun in the heavens. (2.) It shows, that as the planets move in circular orbits about the central earth, they ought at all times to be of the same apparent magnitudes; whereas, on the contrary, we observe their apparent magnitude in the heavens to be very variable, and so far different, that, for instance, Mars will sometimes appear as big as Jupiter nearly, and at other times you will scarcely know him from a fixed star. (3.) It shows that any of the planets might be seen at all distances from the sun in the heavens; or, in other words, that when the sun is setting, Mercury or Venus may be seen not only in the south but even in the east; which circumstances were never yet observed. (4.) You see by this planetarium that the motions of the planets should always be regular and uniformly the same; whereas, on the contrary, we observe them always to move with a variable velocity, sometimes faster, then slower, and sometimes not at all, as will be presently shown. (5.) By the machine you see the planets move all the same way, viz. from west to east continually: but in the heavens we see them move sometimes direct from west to east, sometimes retrograde from east to west, and at other times to be stationary. All which phenomena plainly prove this system to be a false and absurd hypothesis.

The truth of the Copernican or Solar System of the world is hereby most clearly represented. For taking the earth from the *centre*, and placing thereon the usual large brass ball for the sun, and restoring the earth to its proper situation among the planets, then every thing will be right and agree exactly with celestial observations. For turning the winch H, (1.) You will see the planets Mercury and Venus go both before and behind the sun, or have two conjunctions. (2.) You will observe Mercury never to be more than a certain angular distance, 21°, and Venus 47°, from the sun. (3.) That the planets, especially Mars, will be sometimes much nearer to the earth than at others, and therefore must appear larger at one time than at another. (4.) You will see that the planets cannot appear at the earth to move with an uniform velocity; for when nearest they appear to move faster, and slower when most remote. (5.) You will observe the planets will appear at the earth to move sometimes directly from west to east, and then to become retrograde from east to west, and between both to be stationary or without any apparent motion at all. Which particulars all correspond exactly with observations, and fully prove the truth of this excellent system. Fig. 165. represents an apparatus to show these latter particulars more evidently. An hollow wire, with a slit at top, is placed over the arm of the planet Mercury or Venus at E. The arm DG represents a ray of light coming from the planet at D to the earth, and is put over the centre which carries the earth at F. The planets being then put in motion, the planet D, as seen in the heavens from the earth at F, will undergo the several changes of position as above described. The wire prop that is over Mercury at E, may be placed over the other superior planets, Mars, &c. and the same phenomena be exhibited.

By this machine you at *once* see all the planets in motion about the sun, with the same respective velocities and periods of revolution which they have in the heavens; the wheel-work being calculated to a minute of time, from the latest discoveries.

You will see here a demonstration of the earth's motion about the sun, as well as those of the rest of the planets: for if the earth were to be at rest in the heavens, then the time between any two conjunctions of the same kind, or oppositions, would be the same with the periodical time of the planets, viz. 88 days in Mercury, 225 in Venus, &c.; whereas you here observe this time, instead of being 225 days, is no less than 583 days in Venus, occasioned by the earth's moving in the mean time about the sun the same way with the planet. And this space of 583 days always passes between two like conjunctions of Venus in the heavens.

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heavens. Hence the most important point of astronomy is satisfactorily demonstrated.

The diurnal rotation of the earth about its axis, and a demonstration of the cause of the different seasons of the year, and the different lengths of days and nights, are here answered completely: for as the earth is placed on an axis inclining to that of the ecliptic in an angle of 23½ degrees, and is set in motion by the wheel-work, there will be evidently seen the different inclination of the sun's rays on the earth, the different quantity thereof which falls on a given space, the different quantity of the atmosphere they pass through, and the different continuance of the sun above the horizon at the same place in different times of the year; which particulars constitute the difference betwixt heat and cold in the summer and winter seasons.

As the globe of the earth is moveable about its inclined axis, so by having the horizon of London drawn upon the surface of it, and by means of the terminating wire going over it, by which is denoted, that on that side of the wire next the sun is the enlightened half of the earth, and the opposite side the darkened half, you will here see very naturally represented the cause of the different lengths of day and night, by observing the unequal portions of the circle which the island of Great Britain, or the city of London, or any other place, describes in the light and dark hemispheres at different times of the year, by turning the earth on its axis with the hand. But in some of the better orreries on this principle, the earth revolves about its axis by wheel-work.

As to the eclipses of the sun and moon, the true causes of them are here very clearly seen: for by placing the lamp (fig. 166.) upon the centre, in room of the brass ball denoting the sun, and turning the winch until the moon comes into a right line between the centres of the lamp (or sun) and earth, the shadow of the moon will fall upon the earth, and all who live on that part over which the shadow passes will see the sun eclipsed more or less On the other side, the moon passes (in the aforesaid case) through the shadow of the earth, and is by that means eclipsed. And the orbit A (fig. 164.) is so moveable on the two joints called nodes, that any person may easily represent the due position of the nodes and intermediate spaces of the moon's orbit; and thence show when there will or will not be an eclipse of either luminary, and what the quantity of each will be.

While the moon is continuing to move round the earth, the lamp on the centre will so illumine the moon, that you will easily see all her phases, as new, dichotomized, gibbous, full, waning, &c. just as they appear in the heavens. You will moreover observe all the same phases of the earth as they appear at the moon.

The satellites of Jupiter and Saturn are moveable only by the hand; yet may all their phenomena be easily represented, excepting the true relative motions and distances. Thus, if that gilt globe which before represented the sun be made now to denote Jupiter, and four of the primary planets only be retained, then will the Jovian system be represented; and, by candle light only, you will see (the machine being in motion) the immersions and emersions of the satellites into and out of Jupiter's shadow. Yow will see plainly the manner in which they transit his body, and their occultations behind it. You will observe the various ways in which one or more of these moons may at times disappear. And if the machine be set by a white wall, &c. then by the projection of their shadows will be seen the reasons why those moons always appear on each side of Jupiter in a right line, why those which are most remote may appear nearest, and *è contrario*. And the same may be done for Saturn's five moons and his ring.

The method of Rectifying the Orrery, and the proper Manner of placing the Planets in their true Situations.

Having dwelled thus much on the description of orreries, it may be useful to young readers, to point out the method by which the orrery should be first rectified, previous to the exhibition or using of it: and the following is extracted from Mr William Jones's description of his new *Portable Orrery*. "The method of showing the places, and relative aspects of the planets on any day of the year in the planetarium, must be done by the assistance of an *ephemeris* or *almanack*, which among other almanacks is published annually by the Stationers Company.

"The ephemeris contains a diary or daily account of the planets places in the heavens, in signs, degrees, and minutes, both as they appear to the eye supposed to be at the sun, and at the earth, throughout the year. The first of these positions is called the *heliocentric place*, and the latter, the *geocentric place*. The heliocentric place is that made use of in orreries; the geocentric place, that in globes. As an example for finding their places, and setting them right in the orrery, we will suppose the ephemeris (by *White*, which for this purpose is considered the best) at hand, wherein at the bottom of the *left-hand* page for every month is the heliocentric longitudes (or places) of all the planets to every six days of the month; which is near enough for common use: A copy of one of these tables for March 1784 is here inserted for the information of the tyro.

Days	Day increas.	Helioc. long. ♄	Helioc. long. ♃	Helioc. long. ♂	Helioc. long. ⊖	Helioc. long. ♀	Helioc. long. ☿
1	3 11	16 ♑ 56	17 ♒ 11	1 ♋ 30	11 ♍ 37	0 ♐ 35	7 ♍ 58
7	3 35	16 56	17 43	4 23	17 37	10 7	25 23
31	3 59	17 7	18 15	7 15	23 36	19 38	11 ♐ 9
91	4 23	17 17	18 47	10 6	29 33	29 8	28 33
52	4 47	17 28	19 19	12 55	5 ♎ 30	8 ♑ 38	15 ♑ 49

"Now

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" Now as an example, we will suppose, that in order to set the planets of the orrery, we want their heliocentric places for the 21st of this month. Looking into the table, we take the 19th day, which is the nearest to the day wanted: then, accordingly, we find the place of Saturn (♄), is in 17° 17′, or 17 degrees (rejecting the minutes, being in this case useless); of Capricornus (♑), of Jupiter (♃), in 18° of Aquarius (♒), Mars (♀) in 10° of Cancer (♋), the earth (⊖) in 29° of Virgo (♍), Venus (♂) in 29° of Sagittarius, (♐), Mercury (☿) in 28 degrees of the same sign; and in the same manner for any other day therein specified. Upon even this circumstance depends a very pleasing astronomical praxis, by which the young tyro may at any time be able to entertain himself in a most rational and agreeable manner, viz. he may in a minute or two represent the true appearance of the planetary system just as it really is in the heavens, and for any day he pleases, by assigning to each planet its proper place in its orbit; as in the following manner: For the 19th of March, as before, the place of Saturn is in 17° of Capricornus (♑)); now laying hold of the arm of Saturn in the orrery, you place it over or against the 17° of Capricorn on the ecliptic circle, constantly placed on or surrounding the instrument; thus doing the same for the other planets, they will have the proper heliocentric places for that day.

" Now in this situation of the planets, we observe, that if a person was placed on the earth, he would see Venus and Jupiter in the same line and place of the ecliptic, consequently in the heavens they would appear together or in conjunction; Mercury a little to the left or eastward of them, and nearer to the sun; Saturn to the right, or westward, farther from the sun; Mars directly opposite to Saturn; so that when Saturn appears in the west, Mars appears in the east and *vice versa*. Several other curious and entertaining particulars, as depending on the above, may be easily represented and shown by the learner; particularly the foregoing when the winch is turned, and all the planets set into their respective motions."

We cannot close this detail on orreries more agreeably than by the following account of an instrument of that sort invented by Mr James Ferguson, to which he gives the name of a *Mechanical Paradox*, and which is actuated by means of what many, as he observes, even good mechanics, would be ready to pronounce impossible, viz. That the teeth of one wheel taking equally deep into the teeth of three others, should affect them in such a manner, that in turning it any way round its axis, it should turn one of them the *same way*, another the *contrary way*, and the third *no way at all*.

The solution of the paradox is given under the article MECHANICS; after which our author proceeds to give the following account of its uses. " This machine is so much of an orrery, as is sufficient to show the different lengths of days and nights, the vicissitudes of the seasons, the retrograde motion of the nodes of the moon's orbit, the direct motion of the apogeal point of her orbit, and the months in which the sun and moon must be eclipsed.

" On the great immoveable plate A (see fig. 167.) are the months and days of the year, and the signs and degrees of the zodiac so placed, that when the annual index *b* is brought to any given day of the year, it will point to the degree of the sign in which the sun is on that day. The index is fixed to the moveable frame BC, and is carried round the immoveable plate with it, by means of the knob *n*. The carrying this frame and index round the immoveable plate, answers to the earth's annual motion round the sun, and to the sun's apparent motion round the ecliptic in a year.

" The central wheel D (being fixed on the axis *a*, which is fixed in the centre of the immoveable plate) turns the thick wheel E round its own axis by the motion of the frame; and the teeth of the wheel E take into the teeth of the three wheels F, G, H, whose axis turn with one another, like the axis of the hour, minute, and second hands of a clock or watch, where the seconds are shown from the centre of the dial-plate.

" On the upper ends of these axes, are the round plates I, K, L; the plate I being on the axis of the wheel F, K on the axis of G, and L on the axis of H. So that whichever way these wheels are affected, their respective plates, and what they support, must be affected in the same manner; each wheel and plate being independent of the others.

" The two upright wires M and N are fixed into the plate I; and they support the small ecliptic OP, on which, in the machine, the signs and degrees of the ecliptic are marked. This plate also supports the small terrestrial globe *e*, on its inclining axis *f*, which is fixed into the plate near the foot of the wire N. This axis inclines 23½ degrees from a right line, supposed to be perpendicular to the surface of the plate I, and also to the plane of the small ecliptic OP, which is parallel to that plate.

" On the earth *e* is the crescent *g*, which goes more than half way round the earth, and stands perpendicular to the plane of the small ecliptic OP, directly facing the sun Z: Its use is to divide the enlightened half of the earth next the sun from the other half which is then in the dark; so that it represents the boundary of light and darkness, and therefore ought to go quite round the earth; but cannot in a machine, because in some positions the earth's axis would fall upon it. The earth may be freely turned round on its axis by hand, within the crescent, which is supported by the crooked wire *w*, fixed to it, and into the upper plate of the moveable frame BC.

" In the plate K are fixed the two upright wires Q and R: they support the moon's inclined orbits ST in its nodes, which are the two opposite points of the moon's orbit where it intersects the ecliptic OP. The ascending node is marked ☊, to which the descending node is opposite below *e*, but hid from view by the globe *e*. The half ☊ T *e* of this orbit is on the north side of the ecliptic O P, and the other half *e* S ☊ is on the south side of the ecliptic. The moon is not in this machine; but when she is in either of the nodes of her orbit in the heavens, she is then in the plane of the ecliptic: when she is at T in her orbit, she is in her greatest north latitude; and when she is at S, she is in her greatest south latitude.

" In the plate L is fixed the crooked wire U U, which points downward to the small ecliptic OP, and shows the motion of the moon's apogee therein, and its place at any given time.

" The

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"The ball Z reprefents the fun, which is fupported by the crooked wire XY, fixed into the upper plate of the frame at X. A ftraight wire W proceeds from the fun Z, and points always towards the centre of the earth *e*; but toward different points of its furface at different times of the year, on account of the obliquity of its axis, which keeps its parallelifm during the earth's annual courfe round the fun Z; and therefore muft incline fometimes toward the fun, at other times from him, and twice in the year neither toward nor from the fun, but fidewife to him. The wire W is called *the folar ray*.

"As the annual-index *h* fhows the fun's place in the ecliptic for every day of the year, by turning the frame round the axis of the immoveable plate A, according to the order of the months and figns, the folar ray does the fame in the fmall ecliptic OP: for as this ecliptic has no motion on its axis, its figns and degrees ftill keep parallel to thofe on the immoveable plate. At the fame time, the nodes of the moon's orbit ST (or points where it interfects the ecliptic OP) are moved backward, or contrary to the order of figns, at the rate of 19⅓ degrees every Julian year; and the moon's apogeal wire U U is moved forward, or according to the order of the figns of the ecliptic, nearly at the rate of 41 degrees every Julian year; the year being denoted by a revolution of the earth *e* round the fun Z; in which time the annual index *h* goes round the circles of months and figns, on the immoveable plate A.

"Take hold of the knob *n*, and turn the frame round thereby; and in doing this, you will perceive that the north pole of the earth *e* is conftantly before the crefcent *g*, in the enlightened part of the earth toward the fun, from the 20th of March to the 23d of September; and the fouth pole all that time behind the crefcent in the dark; and from the 23d of September to the 20th of March, the north pole as conftantly in the dark behind the crefcent, and the fouth pole in the light before it; which fhows, that there is but one day and one night at each pole, in the whole year; and that when it is day at either pole, it is night at the other.

"From the 20th of March to the 23d of September, the days are longer than the nights in all thofe places of the northern hemifphere of the earth which revolve through the light and dark, and fhorter in thofe of the fouthern hemifphere. From the 23d of September to the 20th of March, the reverfe.

"There are 24 meridian femicircles drawn on the globe, all meeting in its poles: and as one rotation or turn of the earth on its axis is performed in 24 hours, each of thefe meridians is an hour diftant from the other, in every parallel of latitude. Therefore, if you bring the annual index *h* to any given day of the year, on the immoveable plate, you may fee how long the day then is at any place of the earth, by counting how many of thefe meridians are in the light, or before the crefcent, in the parallel of latitude of that place; and this number being fubtracted from 24 hours, will leave remaining the length of the night. And if you turn the earth round its axis, all thofe places will pafs directly under the point of the folar ray, which the fun paffes vertically over on that day, becaufe they are juft as many degrees north or fouth of the equator as the fun's declination is then from the equinoctial.

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"At the two equinoxes, viz. on the 20th of March and 23d of September, the fun is in the equinoctial, and confequently has no declination. On thefe days, the folar ray points directly toward the equator, the earth's poles lie under the inner edge of the crefcent, or boundary of light and darknefs; and in every parallel of latitude there are 12 of the meridians or hour-circles before the crefcent, and 12 behind it, which fhows that the days and nights then are each 12 hours long at all places of the eaath. And if the earth be turned round its axis, you will fee that all places on it go equally through the light and the dark hemifpheres.

"On the 21ft of June, the whole fpace within the north polar circle is enlightened, which is 23½ degrees from the pole, all around; becaufe the earth's axis then inclines 23½ degrees toward the fun: but the whole fpace within the fouth polar circle is in the dark; and the folar ray points toward the tropic of Cancer on the earth, which is 23½ degrees north from the equator. On the 20th of December the reverfe happens, and the folar ray points toward the tropic of Capricorn, which is 23½ degrees fouth from the equator.

"If you bring the annual-index *h* to the beginning of January, and turn the moon's orbit ST by its fupporting wires Q and R till the afcending node (marked ☊) comes to its place in the ecliptic OP, as found by an ephemeris, or by aftronomical tables, for the beginning of any given year; and then move the annual-index by means of the knob *n*, till the index comes to any given day of the year afterward, the nodes will ftand againft their places in the ecliptic on that day; and if you move on the index till either of the nodes comes directly againft the point of the folar ray, the index will then be at the day of the year on which the fun is in conjunction with that node. At the times of thofe new moons which happen within feventeen days of the conjunction of the fun with either of the nodes, the fun will be eclipfed; and at the times of thofe full moons, which happen within twelve days of either of thefe conjunctions, the moon will be eclipfed. Without thefe limits there can be no eclipfes either of the fun or moon; becaufe, in nature, the moon's latitude or declination from the ecliptic is too great for the moon's fhadow to fall on any part of the earth, or for the earth's fhadow to touch the moon.

"Bring the annual-index to the beginning of January, and fet the moon's apogeal wire UU to its place in the ecliptic for that time, as found by aftronomical tables; then move the index forward to any given day of the year, and the wire will point on the fmall ecliptic to the place of the moon's apogee for that time.

"The earth's axis *f* inclines always toward the beginning of the fign Cancer on the fmall ecliptic OP. And if you fet either of the moon's nodes, and her apogeal wire to the beginning of that fign, and turn the plate A about, until the earth's axis inclines toward any fide of the room (fuppofe the north fide), and then move the annual-index round and round the immoveable plate A, according to the order of the months

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months and signs upon it, you will see that the earth's axis and beginning of Cancer will still keep towards the same side of the room, without the least deviation from it; but the nodes of the moon's orbit ST will turn progressively towards all the sides of the room, contrary to the order of signs in the small ecliptic OP, or from east, by south, to west, and so on; and the apogeal wire UU will turn the contrary way to the motion of the nodes, or according to the order of the signs in the small ecliptic, from west, by south, to east, and so on quite round. A clear proof that the wheel F, which governs the earth's axis and the small ecliptic, does not turn any way round its own centre; that the wheel G, which governs the moon's orbit OP, turns round its own centre backward, or contrary both to the motion of the frame BC and thick wheel E; and that the wheel H, which governs the moon's apogeal wire UU, turns round its own centre forward, or in direction both of the motion of the frame and of the thick wheel E, by which the three wheels F, G, and H, are affected.

"The wheels D, E, and F, have each 39 teeth in the machine; the wheel G has 37, and H 44.

"The parallelism of the earth's axis is perfect in this machine; the motion of the apogee very nearly so; the motion of the nodes not quite so near the truth, though they will not vary sensibly therefrom in one year. But they cannot be brought nearer, unless larger wheels, with higher numbers of teeth, are used.

"In nature, the moon's apogee goes quite round the ecliptic in 8 years and 312 days, in direction of the earth's annual motion; and the nodes go round the ecliptic, in a contrary direction, in 18 years and 225 days. In the machine, the apogee goes round the ecliptic OP in eight years and four-fifths of a year, and the nodes in 18 years and a half."

358 Cometarium.

The Cometarium, (fig. 168.) This curious machine shows the motion of a comet or eccentric body moving round the sun, describing equal areas in equal times, and may be so contrived as to show such a motion for any degrees of eccentricity. It was invented by the late Dr Desaguliers.

The dark elliptical groove round the letters *a b c d e f g h i k l m* is the orbit of the comet Y; this comet is carried round in the groove according to the order of letters, by the wire W fixed in the sun S, and slides on the wire as it approaches nearer to or recedes farther from the sun, being nearest of all in the perihelion *a*, and farthest in the aphelion *g*. The areas, *a* S *b*, *b* S *c*, *c* S *d*, &c. or contents of these several triangles, are all equal; and in every turn of the winch N, the comet Y is carried over one of these areas; consequently, in as much time as it moves from *f* to *g*, or from *g* to *h*, it moves from *m* to *a*, or from *a* to *b*; and so of the rest, being quickest of all at *a*, and slowest at *g*. Thus the comet's velocity in its orbit continually decreases from the perihelion *a* to the aphelion *g*; and increases in the same proportion from *g* to *a*.

The elliptic orbit is divided into 12 equal parts or signs, with their respective degrees, and so is the circle *n o p q r s t u*, which represents a great circle in the heavens, and to which the comet's motion is referred by a small knob on the point of the wire W. Whilst the comet moves from *f* to *g* in its orbit, it appears to move only about five degrees in this circle, as is shown by the small knob on the end of the wire W; but in as short time as the comet moves from *m* to *a*, or from *a* to *b*, it appears to describe the large space *t n* or *n o* in the heavens, either of which spaces contains 120 degrees, or four signs. Were the eccentricity of its orbit greater, the greater still would be the difference of its motion, and *vice versa*.

ABCDEFGHIKLM is a circular orbit for showing the equable motion of a body round the sun S, describing equal areas ASB, BSC, &c. in equal times with those of the body Y in its elliptical orbit above mentioned; but with this difference, that the circular motion describes the equal arcs AB, BC, &c, in the same equal times that the elliptical motion describes the unequal arcs, *a b*, *b c*, &c.

Now suppose the two bodies Y and 1 to start from the points *a* and A at the same moment of time, and, each having gone round its respective orbit, to arrive at these points again at the same instant, the body Y will be forwarder in its orbit than the body 1 all the way from *a* to *g*, and from A to G: but 1 will be forwarder than Y through all the other half of the orbit; and the difference is equal to the equation of the body Y in its orbit. At the points *a* A, and *g* G, that is, that in the perihelion and aphelion, they will be equal; and then the equation vanishes. This shows why the equation of a body moving in an elliptic orbit is added to the mean or supposed circular motion from the perihelion to the aphelion, and subtracted from the aphelion to the perihelion, in bodies moving round the sun, or from the perigee to the apogee, and from the apogee to the perigee in the moon's motion round the earth.

This motion is performed in the following manner by the machine, fig. 169. ABC is a wooden bar (in the box containing the wheel-work), above which are the wheels D and E, and below it the elliptic plates FF and GG; each plate being fixed on an axis in one of its focuses, at E and K; and the wheel E is fixed on the same axis with the plate FF. These plates have grooves round their edges precisely of equal diameters to one another, and in these grooves is the cat-gut string *gg*, *gg* crossing between the plates at *h*. On H, the axis of the handle or winch N in fig. 216. is an endless screw in fig. 217. working in the wheels D and E, whose numbers of teeth being equal, and should be equal to the number of lines, *a* S, *b* S, *c* S, &c in fig. 168. they turn round their axis in equal times to one another, and to the motion of the elliptic plates. For, the wheels D and E having equal numbers of teeth, the plate FF being fixed on the same axis with the wheel E, and turning the equally big plate GG by a cat-gut string round them both, they must all go round their axis in as many turns of the handle N as either of the wheels has teeth.

It is easy to see, that the end *h* of the elliptical plate FF being farther from its axis E than the opposite end I is, must describe a circle so much the larger in proportion, and therefore move through so much more space in the same time; and for that reason the end *h* moves so much faster than the end I, although it goes no sooner round the centre E. But then the quick-moving end *h* of the plate FF leads about the short end *h* K of the plate GG with the same velocity;

and

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and the slow-moving end I of the plate FF coming half round as to B, must then lead the long end *k* of the plate GG as slowly about: so that the elliptical plate FF and its axis E move uniformly and equally quick in every part of its revolution; but the elliptical plate GG, together with its axis K, must move very unequally in different parts of its revolution; the difference being always inversely as the distance of any point of the circumference of GG from its axis at K: or in other words, to instance in two points, if the distance K *k* be four, five, or six times as great as the distance K *h*, the point *h* will move in that position, four, five, or six times as fast as the point *k* does, when the plate GG has gone half round; and so on for any other eccentricity or difference of the distances K *k* and K *h*. The tooth I on the plate FF falls in between the two teeth at *k* on the plate GG; by which means the revolution of the latter is so adjusted to that of the former, that they can never vary from one another.

On the top of the axis of the equally-moving wheel D in fig 169. is the sun S in fig. 168: which sun, by the wire fixed to it, carries the ball I round the circle ABCD, &c. with an equable motion, according to the order of the letters: and on the top of the axis K of the unequally-moving ellipses GG, in fig. 169. is the sun S in fig. 168. carrying the ball Y unequally round in the elliptical groove *a b c d*, &c. *N. B.* This elliptical groove must be precisely equal and similar to the verge of the plate GG, which is also equal to that of FF.

In this manner machines may be made to show the true motion of the moon about the earth, or of any planet about the sun, by making the elliptical plates of the same eccentricities, in proportion to the radius, as the orbits of the planets are, whose motions they represent; and so their different equations in different parts of their orbits may be made plain to sight, and clearer ideas of these motions and equations acquired in half an hour, than could be gained from reading half a day about such motions and equations.

359 Celestial globe. The Improved Celestial Globe, fig. 170. On the north pole of the axis, above the hour-circle, is fixed an arch MKH of $23\frac{1}{2}$ degrees; and at the end H is fixed an upright pin HG, which stands directly over the north pole of the ecliptic, and perpendicular to that part of the surface of the globe. On this pin are two moveable collets at E and H, to which are fixed the quadrantile wires N and O, having two little balls on their ends for the sun and moon, as in the figure. The collet D is fixed to the circular plate F, whereon the $29\frac{1}{2}$ days of the moon's age are engraven, beginning just under the sun's wire N; and as this wire is moved round the globe, the plate F turns round with it. These wires are easily turned, if the screw G be slackened; and when they are set to their proper places, the screw serves to fix them there, so as in turning the ball of the globe, the wires with the sun and moon go round with it; and these two little balls rise and set at the same times, and on the same points of the horizon, for the day to which they are rectified, as the sun and moon do in the heavens.

Because the moon keeps not her course in the ecliptic (as the sun appears to do) but has a declination of $5\frac{1}{3}$ degrees on each side from it in every lunation, her ball may be screwed as many degrees to either side of the ecliptic as her latitude or declination from the ecliptic amounts to at any given time.

The horizon is supported by two semicircular arches, because pillars would stop the progress of the balls when they go below the horizon in an oblique sphere.

To rectify this globe. Elevate the pole to the latitude of the place; then bring the sun's place in the ecliptic for the given day to the brazen meridian, and set the hour index at 12 at noon, that is, to the upper 12 on the hour circle; keeping the globe in that situation, slacken the screw G, and set the sun directly over his place on the meridian; which done, set the moon's wire under the number that expresses her age for that day on the plate F, and she will then stand over her place in the ecliptic, and show what constellation she is in. Lastly, fasten the screw G, and adjust the moon to her latitude, and the globe will be rectified.

Having thus rectified the globe, turn it round, and observe on what point of the horizon the sun and moon balls rise and set, for these agree with the points of the compass on which the sun and moon rise and set in the heavens on the given day: and the hour index shows the time of their rising and setting: and likewise the time of the moon's passing over the meridian.

This simple apparatus shows all the varieties that can happen in the rising and setting of the sun and moon; and makes the forementioned phenomena of the harvest moon plain to the eye. It is also very useful in reading lectures on the globes, because a large company can see this sun and moon go round, rising above and setting below the horizon at different times, according to the seasons of the year; and making their appulses to different fixed stars. But in the usual way, where there is only the places of the sun and moon in the ecliptic to keep the eye upon, they are easily lost sight of, unless they be covered with patches.

The Trajectorium Lunare, fig. 171. This machine is for delineating the paths of the earth and moon, showing what sort of curves they make in the ethereal regions. S is the sun, and E the earth, whose centres are 95 inches distant from each other; every inch answering to 1,000,000 of miles. M is the moon, whose centre is $\frac{24}{100}$ parts of an inch from the earth's in this machine, this being in just proportion to the moon's distance from the earth. AA is a bar of wood, to be moved by hand round the axis *g* which is fixed in the wheel Y. The circumference of this wheel is to the circumference of the small wheel L (below the other end of the bar) as $365\frac{1}{4}$ days is to $29\frac{1}{2}$, or as a year is to a lunation. The wheels are grooved round their edges, and in the grooves is the cat gut string GG crossing between the wheels at X. On the axis of the wheel L is the index F, in which is fixed the moon's axis M for carrying her round the earth E (fixed on the axis of the wheel L) in the time that the index goes round a circle of $29\frac{1}{2}$ equal parts, which are the days of the moon's age. The wheel Y has the months and days of the year all round its limb; and in the bar AA is fixed the index *l*, which points out the days of the months answering the days of the moon's age, shown by the index F, in the circle of $29\frac{1}{2}$ equal parts at the other end of the bar. On the

360 Trajectorium lunare.

Deſcription of Aſtronomical Inſtruments.

the axis of the wheel L is put the piece D, below the cock C, in which this axis turns round; and in D are put the pencils *e* and *m* directly under the earth E and moon M; ſo that *m* is carried round *e* as M is round E.

Lay the machine on an even floor, preſſing gently on the wheel Y, to cauſe its ſpiked feet (of which two appear at P and P, the third being ſuppoſed to be hid from ſight by the wheel) enter a little into the floor to ſecure the wheel from turning. Then lay a paper about four feet long under the pencils *e* and *m*, croſswiſe to the bar; which done, move the bar ſlowly round the axis *g* of the wheel Y; and as the earth E goes round the ſun S, the moon M will go round the earth with a duly proportioned velocity; and the friction wheel W running on the floor, will keep the bar from bearing too heavily on the pencils *e* and *m*, which will delineate the paths of the earth and moon. As the index I points out the days of the months, the index F ſhows the moon's age on theſe days, in the circle of $29\frac{1}{2}$ equal parts. And as this laſt index points to the different days in its circle, the like numeral figures may be ſet to thoſe parts of the curves of the earth's path and moon's where the pencils *e* and *m* are at thoſe times reſpectively, to ſhow the places of the earth and moon. If the pencil *e* be puſhed a very little off, as if from the pencil *m*, to about $\frac{1}{40}$ part of their diſtance, and the pencil *m* puſhed as much towards *e*, to bring them to the ſame diſtances again, though not to the ſame points of ſpace; then, as *m* goes round *e*, *e* will go as it were round the centre of gravity between the earth *e* and moon *m*; but this motion will not ſenſibly alter the figure of the earth's path or the moon's.

If a pin, as *p*, be put through the pencil *m*, with its head towards that of the pin *q* in the pencil *e*, its head will always keep thereto as *m* goes round *e*, or as the ſame ſide of the moon is ſtill obverted to the earth. But the pin *p*, which may be conſidered as an equatorial diameter of the moon, will turn quite round the point *m*, making all poſſible angles with the line of its progreſs, or line of the moon's path. This is an ocular proof of the moon's turning round her axis.

III. *A Deſcription of the principal Aſtronomical Inſtruments by which Aſtronomers make the moſt accurate Obſervations.*

By practical aſtronomy is implied the knowledge of obſerving the celeſtial bodies with reſpect to their poſition and time of the year, and of deducing from thoſe obſervations certain concluſions uſeful in calculating the time when any propoſed poſition of theſe bodies ſhall happen.

For this purpoſe, it is neceſſary to have a room or place conveniently ſituated, ſuitably contrived, and furniſhed with proper aſtronomical inſtruments. It ſhould have an uninterrupted view from the zenith down to (or even below) the horizon, at leaſt towards its cardinal points; and for this purpoſe, that part of the roof which lies in the direction of the meridian, in particular, ſhould have moveable covers, which may eaſily be moved and put on again; by which means an inſtrument may be directed to any point of the heavens between the horizon and the zenith, as well to the northward as ſouthward.

This place, called an Obſervatory, ſhould contain ſome, if not all, of the following inſtruments:

I. A Pendulum Clock, for ſhowing equal time. This ſhould ſhow time in hours, minutes, and ſeconds; and with which the obſerver, by hearing the beats of the pendulum, may count them by his ear, while his eye is employed on the motion of the celeſtial object he is obſerving. Juſt before the object arrives at the poſition deſcribed, the obſerver ſhould look on the clock and remark the time, ſuppoſe it 9 hours 15 minutes 25 ſeconds; then ſaying, 25, 26, 27, 28, &c. reſponſive to the beat of the pendulum, till he ſees through the inſtrument the object arrived at the poſition expected; which ſuppoſe to happen when he ſays 38, he then writes down 9h. 15 min. 38 ſec. for the time of obſervation, annexing the year and the day of the month. If two perſons are concerned in making the obſervation, one may read the time audibly while the other obſerves through the inſtrument, the obſerver repeating the laſt ſecond read when the deſired poſition happens.

II. An Achromatic Refracting Telescope, or a reflecting one, of two feet at leaſt in length, for obſerving particular phenomena. Theſe inſtruments are particularly deſcribed under Optics.

III. A Micrometer, for meaſuring ſmall angular diſtances. See Micrometer.

IV. Astronomical Quadrants, both mural and portable, for obſerving meridian and other altitudes of the celeſtial bodies. 361 Quadrants.

1. The *mural quadrant* is in the form of a quarter of a circle, contained under two radii at right angles to one another, and an arch equal to one fourth part of the circumference of the circle. It is the moſt uſeful and valuable of all the aſtronomical inſtruments; and as it is ſometimes fixed to the ſide of a ſtone or brick wall, and the plane of it erected exactly in the plane of the meridian, it in this caſe receives the name of *mural quadrant* or *arch*.

Tycho-Brahe was the firſt perſon who contrived this mural arch, viz. who firſt applied it to a wall; and Mr Flamſtead, the firſt in England who, with indefatigable pains, fixed one up in the royal obſervatory at Greenwich.

Theſe inſtruments have uſually been made from five to eight feet radius, and executed by thoſe late celebrated ariſts Siſſon, Graham, Bird, and other eminent mathematical inſtrument makers in London. The conſtruction of them being generally the ſame in all the ſizes, we ſhall here deſcribe one made by the late Joh. Siſſon, under the direction of the late M. Graham. Fig 172. repreſents the inſtrument as alreay fixed to the wall. It is of copper, and of about five feet radius. The frame is formed of flat bars, and ſtrengthened by edge bars affixed underneath perpendicularly to them. The radii HB, HA, being divided each into four equal parts, ſerve to find out the points D and E, by which the quadrant is freely ſuſpended on its props or iron ſupports that are faſtened ſecurely in the wall.

One of the ſupports E is repreſented ſeparately in *e* on one ſide of the quadrant. It is moveable by means of a long ſlender rod EF or *ef*, which goes into a hol-

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low screw in order to restore the instrument to its situation when it is discovered to be a little deranged. This may be known by the very fine perpendicular thread HA, which ought always to coincide with the same point A of the limb, and carefully examined to be so by a small magnifying telescope at every observation. In order to prevent the unsteadiness of so great a machine, there should be placed behind the limb four copper ears with double cocks I, K, I, K. There are others along the radii HA and HB. Each of these cocks contains two screws, into which are fastened the ears that are fixed behind the quadrant.

Over the wall or stone which supports the instrument, and at the same height as the centre, is placed horizontally the axis PO, which is perpendicular to the plane of the instrument, and which would pass through the centre if it was continued. This axis turns on two pivots P. On this axis is fixed at right angles another branch ON, loaded at its extremity with a weight N capable of equipoising with its weight that of the telescope LM; whilst the axis, by its extremity nearest the quadrant, carries the wooden frame PRM, which is fastened to the telescope in M. The counterpoise takes off from the observer the weight of the telescope when he raises it, and hinders him from either forcing or straining the instrument.

The lower extremity (V) of the telescope is furnished with two small wheels, which takes the limb of the quadrant on its two sides. The telescope hardly bears any more upon the limb than the small friction of these two wheels; which renders its motion so extremely easy and pleasant, that by giving it with the hand only a small motion, the telescope will run of itself over a great part of the limb, balanced by the counterpoise N

When the telescope is to be stopped at a certain position, the copper hand T is to be made use of, which embraces the limb and springs at the bottom. It is fixed by setting a screw, which fastens it to the limb. Then, in turning the regulating screw, the telescope will be advanced; which is continued until the star or other object whose altitude is observing be on the horizontal fine thread in the telescope. Then on the plate X supporting the telescope, and carrying a vernier or nonius, will be seen the number of degrees and minutes, and even quarters of minutes, that the angular height of the object observed is equal to. The remainder is easily estimated within two or three seconds nearly.

There are several methods of subdividing the divisions of a mural quadrant, which are usually from five to ten minutes each; but that which is most commonly adopted is by the vernier or nonius, the contrivance of Peter Vernier a Frenchman. This vernier consists of a piece of copper or brass, CDAB (fig. 173.), which is a small portion of X (fig. 172.) represented separately. The length CD is divided into 20 equal parts, and placed contiguously on a portion of the division of the limb of the quadrant containing 21 divisions, and thereby dividing this length into 20 equal parts. Thus the first division of the vernier piece marked 15, beginning at the point D, is a little matter backward, or to the left of the first division of the limb equal to 15. The second division of the vernier is to the left of the second division of the limb double of the first difference, or 30″; and so on unto the 20th and last division on the left of the vernier piece; where the 20 differences being accumulated each of the 20th part of the division of the limb, this last division will be found to agree exactly with the 21st division on the limb of the quadrant.

The index must be pushed the 20th part of a division, or 15″, to the right; for to make the second division on the vernier coincide with one of the divisions of the limb, in like manner is moving two 20ths, or 30″, we must look at the second division of the index, and there will be a concidence with a division of the limb. Thus may be conceived that the beginning D of the vernier, which is always the line of reckoning, has advanced two divisions, or 30″, to the right, when the second division, marked 30 on the vernier, is seen to correspond exactly with one of the lines of the quadrant.

By means of this vernier may be readily distinguished the exactitude of 15″ of the limb of a quadrant five feet radius, and simply divided into 5′. By an estimation by the eye, afterwards, the accuracy of two or three seconds may be easily judged. On the side of the quadrant is placed the plate of copper which carries the telescope. This plate carries two verniers. The outer line CD divides five minutes into 20 parts, or 15″ each. The interior line AB answers to the parts of another division not having 90°, but 96 parts of the quadrant. It is usually adopted by English astronomers on account of the facility of its subdivisions. Each of the 96 portions of the quadrant is equivalent to 56′ 15″ of the usual divisions. It is divided on the limb into 16 parts, and the arch of the vernier AB contains 25 of these divisions; and being divided itself into 24, immediately gives parts, the value of each of which is 8″ 47$\frac{1}{2}$‴. From this mode a table of reduction may easily be constructed, which will serve to find the value of this second mode of dividing in degrees, minutes, and seconds, reckoning in the usual manner, and to have even the advantage of two different modes; which makes an excellent verification of the divisions on the limb of the quadrant and observed heights by the vernier.

2. The *Portable Astronomical Quadrant*, is that instrument of all others which astronomers make the greatest use of, and have the most esteem for. They are generally made from 12 to 23 inches. Fig. 174. is a representation of the improved modern one as made by the late Mr Sisson and by the present mathematical instrument makers. This is capable of being carried to any part of the world, and put up for observation in an easy and accurate manner. It is made of brass, and strongly framed together by crossed perpendicular bars. The arch AC, and telescope EF, are divided and constructed in a similar manner to the mural quadrant, but generally without the division of 96 parts. The counterpoise to the telescope T is represented at P, and also another counterpoise to the quadrant itself at P. The quadrant is fixed to a long axis, which goes into the pillar KR. Upon this axis is fixed an index, which points to and subdivides by a vernier the divisions of the azimuth circle K. This azimuth circle is extremely useful for taking the azimuth of a celestial body at the same time its altitude is observed.

The

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The upper end of the axis is firmly connected with the adjusting frame GH; and the pillar is supported on the crossed feet at the bottom of the pillar KR with the adjusting screws *a*, *b*, *c*, *d*.

When this instrument is set up for use or observation, it is necessary that two adjustments be very accurately made: One, that the plane or surface of the instrument be truly perpendicular to the horizon; the other, that the line supposed to be drawn from the centre to the first line of the limb, be truly on a level or parallel with the horizon. The first of these particulars is done by means of the thread and plummet *p*; the thread of which is usually of very fine silver wire, and it is placed opposite to a mark made upon the end of the limb of the instrument. The four screws at the foot, *a*, *b*, *c*, *d*, are to be turned until a perfect coincidence is observed of the thread upon the mark, which is accurately observed by means of a small telescope T, that fits to the limb. The other adjustment is effected by means of the spirit level L, which applies on the frame GH, and the small screws turned as before until the bubble of air in the level settles in the middle of the tube. The dotted tube EB is a kind of prover to the instrument: for by observing at what mark the centre of it appears against, or by putting up a mark against it, it will at any time discover if the instrument has been displaced. The screw S at the index, is the regulating or adjusting screw, to move the telescope and index, during the observation, with the utmost nicety.

362 Equatorial sector.

V. Astronomical *or* Equatorial Sector. This is an instrument for finding the difference in right ascension and declination between two objects, the distance of which is too great to be observed by the micrometer. It was the invention of the late ingenious Mr George Graham, F. R. S. and is constructed from the following particulars. Let AB (fig. 175.) represent an arch of a circle containing 10 or 12 degrees well divided, having a strong plate CD for its radius, fixed to the middle of the arch at D: let this radius be applied to the side of an axis HFI, and be moveable about a joint fixed to it at F, so that the plane of the sector may be always parallel to the axis HI; which being parallel to the axis of the earth, the plane of the sector will always be parallel to the plane of some hour-circle. Let a telescope CE be moveable about the centre C of the arch AB, from one end of it to the other, by turning a screw at G; and let the line of sight be parallel to the plane of the sector. Now, by turning the whole instrument about the axis HI, till the plane of it be successively directed, first to one of the stars and then to another, it is easy to move the sector about the joint F, into such a position, that the arch AB, when fixed, shall take in both the stars in their passage, by the plane of it, provided the difference of their declinations does not exceed the arch AB. Then, having fixed the plane of the sector a little to the westward of both the stars, move the telescope CE by the screw G; and observe by a clock the time of each transit over the cross hairs, and also the degrees and minutes upon the arch AB, cut by the index at each transit; then in the difference of the arches, the difference of the declinations, and by the difference of the times, we have the difference of the right ascensions of the stars.

The dimensions of this instrument are these: The length of the telescope, or the radius of the sector, is $2\frac{1}{2}$ feet; the breadth of the radius, near the end C, is $1\frac{1}{4}$ inch; and at the end D two inches. The breadth of the limb AB is $1\frac{1}{2}$ inch; and its length six inches, containing ten degrees divided into quarters, and numbered from either end to the other. The telescope carries a nonius or subdividing plate, whose length, being equal to sixteen quarters of a degree, is divided into fifteen equal parts; which, in effect, divides the limb into minutes, and, by estimation, into smaller parts. The length of the square axis HIF is eighteen inches, and of the part HI twelve inches; and its thickness is about a quarter of an inch: the diameters of the circles are each five inches: the thickness of the plates, and the other measures, may be taken at the direction of a workman.

This instrument may be rectified, for making observations, in this manner: By placing the intersection of the cross hairs at the same distance from the plane of the sector, as the centre of the object-glass, the plane described by the line of sight, during the circular motion of the telescope upon the limb, will be sufficiently true, or free from conical curvity; which may be examined by suspending a long plumb-line at a convenient distance from the instrument; and by fixing the plane of the sector in a vertical position, and then by observing, while the telescope is moved by the screw along the limb, whether the cross hairs appear to move along the plumb-line.

The axis *bfo* may be elevated nearly parallel to the axis of the earth, by means of a small common quadrant; and its error may be corrected, by making the line of sight follow the circular motion of any of the circumpolar stars, while the whole instrument is moved about its axis *hfo*, the telescope being fixed to the limb; for this purpose, let the telescope *kl* be directed to the star *a*, when it passes over the highest point of its diurnal circle, and let the division cut by the nonius be then noted; then, after twelve hours, when the star comes to the lowest point of its circle, having turned the instrument half round its axis, to bring the telescope into the position *mn*; if the cross hairs cover the same star supposed at *b*, the elevation of the axis *hfo* is exactly right; but if it be necessary to move the telescope into the position *uv*, in order to point to this star at *c*, the arch *mu*, which measures the angle *mfu* or *bfc*, will be known; and then the axis *bfo* must be depressed half the quantity of this given angle if the star passed below *b*, or must be raised so much higher if above it; and then the trial must be repeated till the true elevation of the axis be obtained. By making the like observations upon the same star on each side the pole, in the six-o'clock hour-circle, the error of the axis, toward the east or west, may also be found and corrected, till the cross hairs follow the star quite round the pole; for supposing *aopbc* to be an arch of the meridian (or in the second practice of the six-o'clock hour-circle), make the angle *afp* equal to half the angle *afc*, and the line *fp* will point to the pole; and the angle *ofp*, which is the error of the axis, will be equal to half the angle *bfc*, or *mfu*, found by the observation; because the difference of the two angles *afb*, *afc*, is double the difference of their halves *afo* and *afp*. Unless the star be very

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very near the pole, allowance must be made for refractions.

VI. Transit and Equal Altitude Instruments.

363 Transit Instruments.

1. *The Transit Instrument* is used for observing objects as they pass over the meridian. It consists of a telescope fixed at right angles to a horizontal axis; which axis must be so supported that what is called the line of collimation, or line of sight of the telescope, may move in the plane of the meridian. This instrument was first made by the celebrated Mr Romer in the year 1689, and has since received great improvements. It is made of various sizes, and of large dimensions in our great observatories; but the following is one of a size sufficiently large and accurate for all the useful purposes.

The axis AB (fig. 176), to which the middle of the telescope is fixed, is about $2\frac{1}{2}$ feet long, tapering gradually toward its ends, which terminate in cylinders well turned and smoothed. The telescope CD, which is about four feet and $1\frac{1}{2}$ inch diameter, is connected with the axis by means of a strong cube or die G, and in which the two cones MQ, forming the axis, are fixed. This cube or stock G serves as the principal part of the whole machine. It not only keeps together the two cones, but holds the two sockets KH, of 15 inches length, for the two telescopic tubes. Each of these sockets has a square base, and is fixed to the cube by four screws. These sockets are cut down in the sides about eight inches, to admit more easily the tube, of the telescope; but when the tube is inserted, it is kept in firm by screwing up the tightening screws at the end of the sockets at K and H. These two sockets are very useful in keeping the telescope in its greatest possible degree of steadiness. They also afford a better opportunity of balancing the telescope and rectifying its vertical thread, than by any other means.

In order to direct the telescope to the given height that a star would be observed at, there is fixed a semicircle AN on one of the supporters, of about $8\frac{1}{2}$ inches diameter, and divided into degrees. The index is fixed on the axis, at the end of which is a vernier, which subdivides the degrees into 12 parts, or five minutes. This index is moveable on the axis, and may be closely applied to the divisions by means of a tightening screw.

Two upright posts of wood or stone YY, firmly fixed at a proper distance, are to sustain the supporters of this instrument. These supporters are two thick brass plates RR, having well smoothed angular notches in their upper ends, to receive the cylindrical arms of the axis. Each of these notched plates is contrived to be moveable by a screw, which slides them upon the surfaces of two other plates immoveably fixed upon the two upright pillars; one plate moving in a horizontal, and the other in a vertical direction; or, which is more simple, these two modes are sometimes applied only on one side, as at V and P, the horizontal motion by the screw P, and the vertical by the screw V. These two motions serve to adjust the telescope to the planes of the horizon and meridian: to the plane of the horizon by the spirit-level EF, hung by DC on the axis MQ, in a parallel direction; and to the plane of the meridian in the following manner:

Observe by the clock when a circumpolar star seen through this instrument transits both above and below the pole; and if the times of describing the eastern and western parts of its circuit are equal, the telescope is then in the plane of the meridian: otherwise the screw P must be gently turned that it may move the telescope so much that the time of the star's revolution be bisected by both the upper and lower transits, taking care at the same time that the axis remains perfectly horizontal. When the telescope is thus adjusted, a mark must be set at a considerable distance (the greater the better) in the horizontal direction of the intersection of the cross wires, and in a place where it can be illuminated in the night-time by a lanthorn hanging near it; which mark being on a fixed object, will serve at all times afterwards to examine the position of the telescope by, the axis of the instrument being first adjusted by means of the level.

To adjust the Clock by the Sun's Transit over the Meridian. Note the times by the clock when the preceding and following edges of the sun's limb touch the cross wires. The difference between the middle time and 12 hours, shows how much the mean, or time by the clock, is faster or slower than the apparent or solar time for that day: to which the equation of time being applied, will show the time of mean noon for that day, by which the clock may be adjusted.

2. *The Equal Altitude Instrument*, is an instrument that is used to observe a celestial object when it has the same altitude on both the east and west sides of the meridian, or in the morning and afternoon. It principally consists of a telescope about 30 inches long fixed to a sextantal or semicircular divided arch; the centre of which is fixed to a long vertical axis: but the particulars of this instrument the reader will see explained in Optics.

3. *Compound Transit Instrument.* Some instruments have been contrived to answer both kinds of observations, viz. either a transit or equal altitudes. Fig. 178. represents such an instrument, made first of all for Mr le Monnier, the French astronomer, by the late Mr Sisson, under the direction of Mr Opaham, mounted and fixed up ready for observation.

AB is a telescope, which may be 3, 4, 5, or 6 feet long, whose cylindrical tube fits exactly into another hollow cylinder *ab*, perpendicular to the axis: these several pieces are of the best hammered plate brass. The cylindrical extremity of this axis MN are of solid bell-metal, and wrought exquisitely true, and exactly the same size, in a lathe; and it is on the perfection to which the cylinders or trunnions are turned that the justness of the instrument depends. In the common focus of the object-glass and eye-glass is placed a reticle (fig. 177.), consisting of three horizontal and parallel fine-stretched silver wires, fixed by pins or screws to a brass circle, the middle one passing through its centre, with a fourth vertical wire likewise passing through the centre, exactly perpendicular to the former three.

The horizontal axis MN (fig. 178.) is placed on a strong brass frame, into the middle of which a steel cylinder GH is fixed perpendicularly, being turned truly round, and terminating in a conical point at its lower extremity; where it is let into a small hole drilled in the middle of the dove-tail slider; which slider is supported

Description of Astronomical Instruments. supported by a hollow tube fixed to the supporting piece IK, consisting of two strong plates of brass, joined together at right angles, to which are fixed two iron cramps L, L, by which it is fastened to the stone wall of a south window.

The upper part G of the steel spindle is embraced by a collar *d e f*, being in contact with the blunt extremity of three screws, whose particular use will be explained by and by. O is another cylindrical collar closely embracing the steel spindle at about a third part of its length from the top; by the means of a small screw it may be loosened or pinched close as occasion requires. From the bottom of this collar proceeds an arm or lever acted upon by the two screws *g h*, whereby the whole instrument, excepting the supporting piece, may be moved laterally, so that the telescope may be made to point at a distant mark fixed in the vertical of the meridian. *i k* is a graduated semicircle of thin brass screwed to the telescope, whereby it may be elevated so as to point to a known celestial object in the day time. *l m* is a spirit-level parallel to the axis of rotation on the telescope, on which two trunnions hang by two hooks at M and N. Along the upper side of the glass tube of the level slides a pointer to be set to the end of the air-bubble; and when the position of the axis of rotation is so adjusted by the screws that the air-bubble keeps to the pointer for a whole revolution of the instrument, the spindle GH is certainly perpendicular to the horizon, and then the line of collimation of the telescope describes a circle of equal altitude in the heavens. When the level is suspended on the axis, raise or depress the tube of the level by twisting the neb of the screw *n* till you bring either end of the air-bubble to rest at any point towards the middle of the tube, to which slide the index; then lift off the level, and, turning the ends of it contrary ways, hang it again on the trunnions; and if the air-bubble rests exactly again, the index as before, the axis of rotation is truly horizontal: If not, depress that end of the axis which lies on the same side of the pointer as the bubble does, by turning the neb of the screw at N, till the bubble returns about halfway towards the pointer; then having moved the pointer to the place where it now rests, invert the ends of the level again, and repeat the same practice till the bubble rests exactly at the pointer in both positions of the level. If, after the telescope is turned upside down, that is, after the trunnions are inverted end for end, you perceive that the same point of a remote fixed object is covered by the vertical wire in the focus of the telescope, that was covered by it before the inversion, it is certain that the line of sight or collimation is perpendicular to the transverse axis; but if the said vertical wire covers any other point, the brass circle that carries the hairs must be moved by a screw-key introduced through the perforation in the side of the tube at X, till it appears to bisect the line joining these two points as near as you can judge; then, by reverting the axis to its former position, you will find whether the wires be exactly adjusted. N. B. The ball *o* is a counterpoise to the centre of gravity of the semicircle *i k*, without which the telescope would not rest in an oblique elevation without being fixed by a screw or some other contrivance.

The several beforementioned verifications being accomplished, if the telescope be elevated to any angle with the horizon, and there stopped, all fixed stars which pass over the three horizontal wires of the reticle on the eastern side of the meridian in ascending, will have precisely the same altitudes when in descending they again cross the same respective wires on the west side, and the middle between the times of each respective equal altitude will be the exact moment of the star's culminating or passing the meridian. By the help of a good pendulum-clock, the hour of their true meridional transits will be known, and consequently the difference of right ascension of different stars. Now, since it will be sufficient to observe a star which has north declination two or three hours before and after its passing the meridian, in order to deduce the times of its arrival at that circle; it follows, that having once found the difference of right ascension of two stars about 60 degrees asunder, and you again observe the first of these stand at the same altitude both in the east and west side, you infer with certainty the moment by the clock at which the second star will be on the meridian that same night, and by this means the transit instrument may be fixed in the true plane of the meridian till the next day; when, by depressing it to some distant land objects, a mark may be discovered whereby it may ever after be rectified very readily, so as to take the transits of any of the heavenly bodies to great exactness, whether by night or day.

When such a mark is thus found, the telescope being directed carefully to it, must be fixed in that position by pinching fast the end of the arm or lever between the two opposite screws *g h*; and if at any future time, whether from the effect of heat or cold on the wall to which the instrument is fixed, or by any settling of the wall itself, the mark appears no longer well bisected by the vertical wire, the telescope may easily be made to bisect it again, by giving a small motion to the pinching screws.

The transit instrument is now considered as one of the most essential particulars of the apparatus of an astronomical observatory.

Besides the above, may be mentioned,

The EQUATORIAL *or* PORTABLE OBSERVATORY; an instrument designed to answer a number of useful purposes in practical astronomy, independent of any particular observatory. It may be made use of in any steady room or place, and performs most of the useful problems in the science. The following is a description of one lately invented by Mr Ramsden, from whom it has received the name of the *Universal Equatorial*. 364 Portable observatory.

The principal parts of this instrument (fig. 179.) are, 1. The azimuth or horizontal circle A, which represents the horizon of the place, and moves on a long axis B, called the *vertical axis*. 2. The equatorial or hour circle C, representing the equator, placed at right angles to the polar axis D, or the axis of the earth, upon which it moves. 3. The semicircle of declination E, on which the telescope is placed, and moving on the axis of declination, or the axis of motion of the line of collimation F. These circles are measured and divided as in the following table;

Measures

Description of Astronomical Instruments.

Measures of the several circles and divisions on them.	Radius. In dec.	Limb divided to	Nonius of 30 gives seconds.	Divided on limb into parts of inc.	Divided by Nonius into parts of inc.
Azimuth or horizontal circle	5 1	15′	30″	45th	1350th
Equatorial or hour circle	5 1	15′ / 1′ in time	30′ / 2″	45th	1350th
Vertical semicircle for declination or latitude.	5 5	15′	30″	42d	1260th

4. The telescope, which is an achromatic refractor with a triple object-glass, whose focal distance is 17 inches, and aperture 2.45 inches, and furnished with six different eye-tubes; so that its magnifying powers extend from 44 to 168. The telescope in this equatorial may be brought parallel to the polar axis, as in the figure, so as to point to the pole star in any part of its diurnal revolution; and thus it has been observed near noon, when the sun has shone very bright. 5. The apparatus for correcting the error in altitude occasioned by refraction, which is applied to the eye-end of the telescope, and consists of a slide G moving in a groove or dove-tail, and carrying the several eye-tubes of the telescope, on which slide there is an index corresponding to five small divisions engraved on the dove-tail; a very small circle, called the refraction circle H, moveable by a finger-screw at the extremity of the eye-end of the telescope; which circle is divided into half minutes, one entire revolution of it being equal to 3′ 18″, and by its motion raises the centre of the cross hairs on a circle of altitude; and likewise a quadrant I of 1½ inch radius, with divisions on each side, one expressing the degree of altitude of the object viewed, and the other expressing the minutes and seconds of error occasioned by refraction, corresponding to that degree of altitude: to this quadrant is joined a small round level K, which is adjusted partly by the pinion that turns the whole of this apparatus, and partly by the index of the quadrant; for which purpose the refraction circle is set to the same minute, &c. which the index points to on the limb of the quadrant; and if the minute, &c. given by the quadrant exceed the 3′ 18″ contained in one entire revolution of the refraction circle, this must be set to the excess above one or more of its entire revolutions; then the centre of the cross hairs will appear to be raised on a circle of altitude to the additional height which the error of refraction will occasion at that altitude.

This instrument stands on three feet L distant from each other 14.4 inches; and when all the parts are horizontal is about 29 inches high: the weight of the equatorial and apparatus is only 59 lb. avoirdupoise, which are contained in a mahogany case weighing 58 lb.

The principal adjustment in this instrument is that of making the line of collimation to describe a portion of an hour-circle in the heavens; in order to which, the azimuth circle must be truly level, the line of collimation or some corresponding line represented by the small brass rod M parallel to it, must be perpendicular to the axis of its own proper motion; and this last axis must be perpendicular to the polar axis; on the brass rod M there is occasionally placed a hanging level N, the use of which will appear in the following adjustments:

The azimuth circle may be made level by turning the instrument till one of the levels is parallel to an imaginary line joining two of the feet screws; then adjust that level with these two-feet screws; turn the circle half round, i. e. 180°; and if the bubble be not then right, correct half the error by the screw belonging to the level, and the other half error by the two-foot screws; repeat this till the bubble comes right; then turn the circle 90° from the two former positions, and set the bubble right, if it be wrong, by the foot screw at the end of the level; when this is done, adjust the other level by its own screw, and the azimuth circle will be truly level. The hanging level must then be fixed to the brass rod by two hooks of equal length, and made truly parallel to it: for this purpose make the polar axis perpendicular or nearly perpendicular to the horizon; then adjust the level by the pinion of the declination-semicircle; reverse the level, and if it be wrong, correct half the error by a small steel screw that lies under one end of the level, and the other half-error by the pinion of the declination-semicircle; repeat this till the bubble be right in both positions. In order to make the brass rod on which the level is suspended at right angles to the axis of motion of the telescope or line of collimation, make the polar axis horizontal, or nearly so: set the declination-semicircle to 0°, turn the hour-circle till the bubble comes right; then turn the declination-circle to 90°; adjust the bubble by raising or depressing the polar axis (first by hand till it be nearly right, afterwards tighten with an ivory key the socket which runs on the arch with the polar axis, and then apply the same ivory key to the adjusting screw at the end of the said arch till the bubble comes quite right); then turn the declination-circle to the opposite 90°; if the level be not then right, correct half the error by the aforesaid adjusting screw at the end of the arch, and the other half error by the two screws which raise or depress the end of the brass rod. The polar axis remaining nearly horizontal as before, and the declination-semicircle at 0°, adjust the bubble by the hour-circle; then turn the declination-semicircle to 90°, and adjust the bubble by raising or depressing the polar axis; then turn the hour-circle 12 hours; and if the bubble be wrong, correct half the error by the polar axis, and the other half error by the two pair of capstan screws at the feet of the two supports on one side of the axis of motion

Fig. 1.

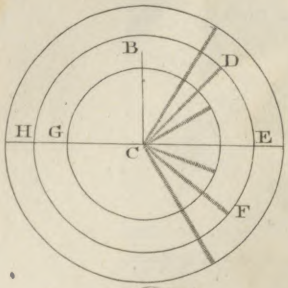


Fig. 2.

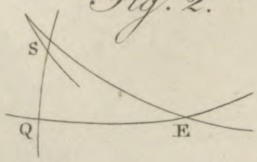


Fig. 3.

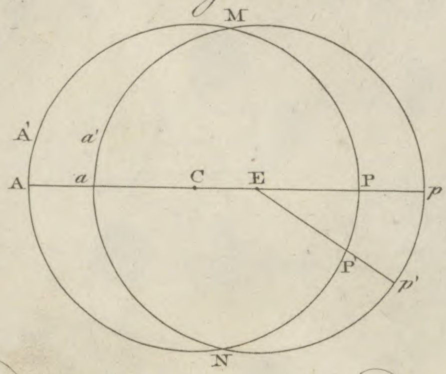


Fig. 4.

Fig. 5.

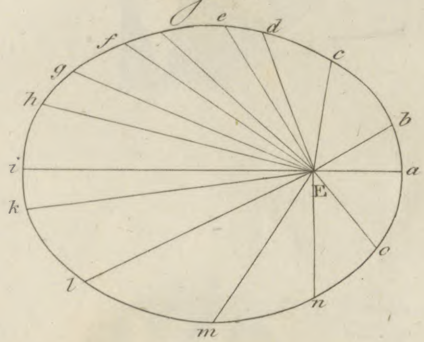
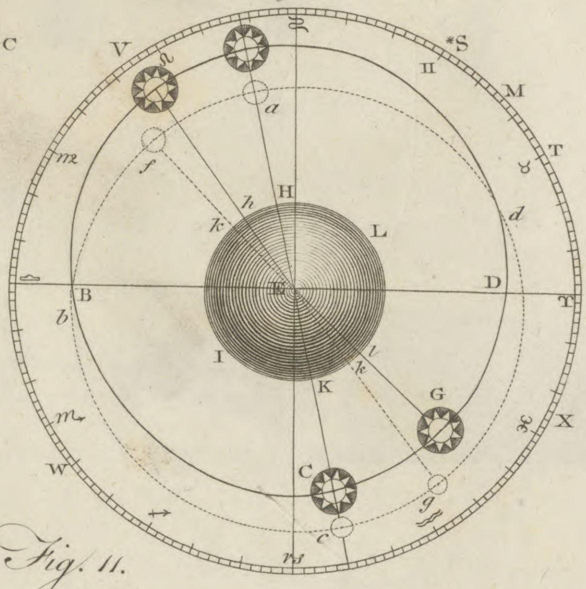


Fig. 6.

Fig. 8.



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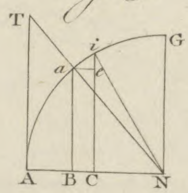

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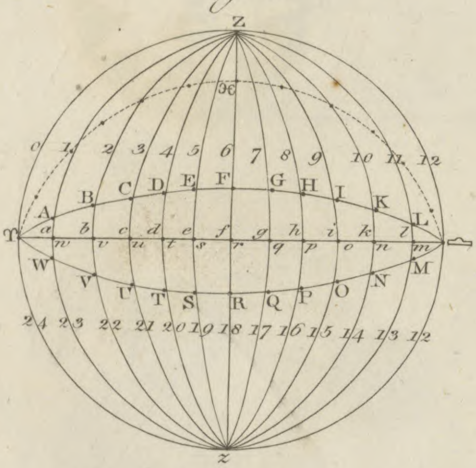

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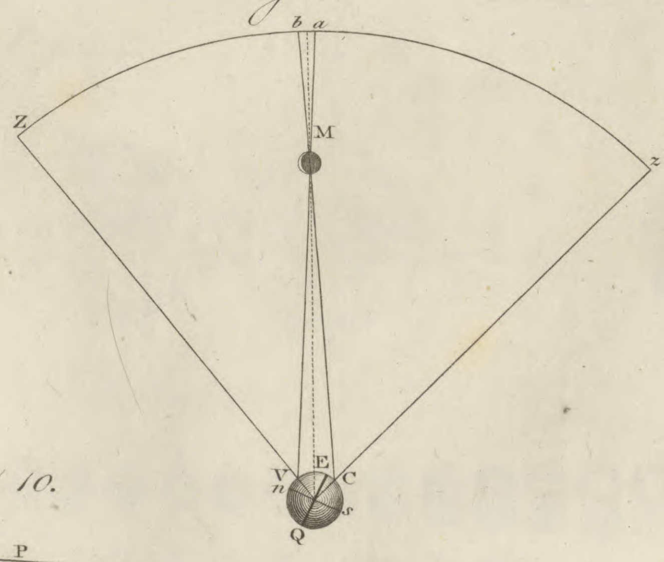

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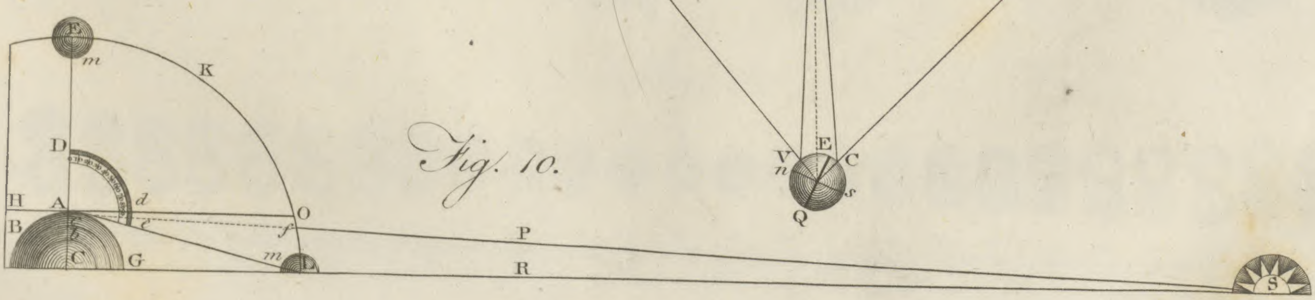
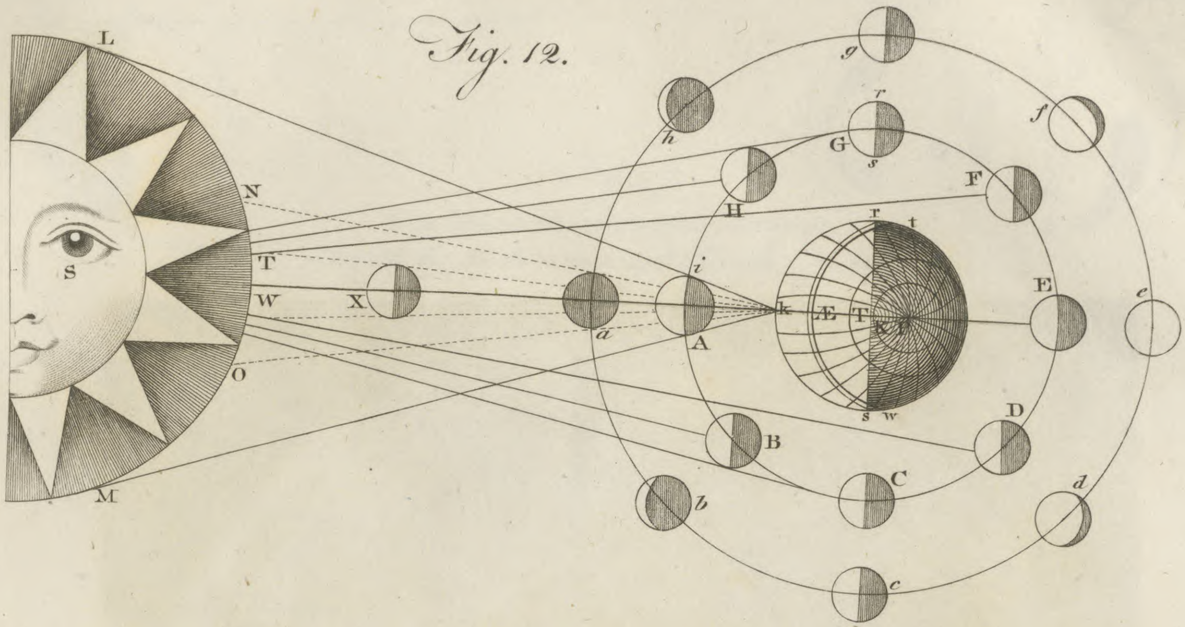


A. Bell Prin. Wal. Sculptor fecit.

Fig. 12.



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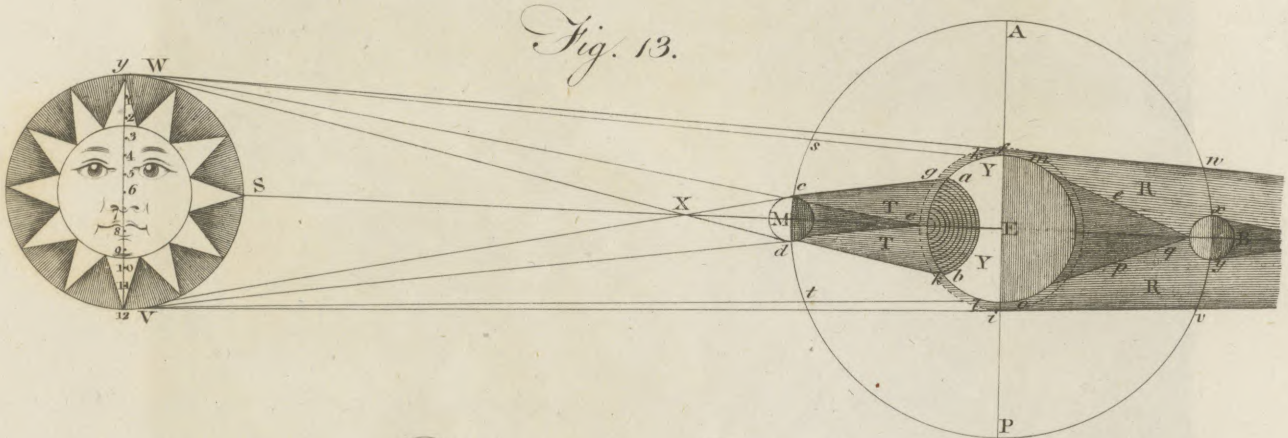
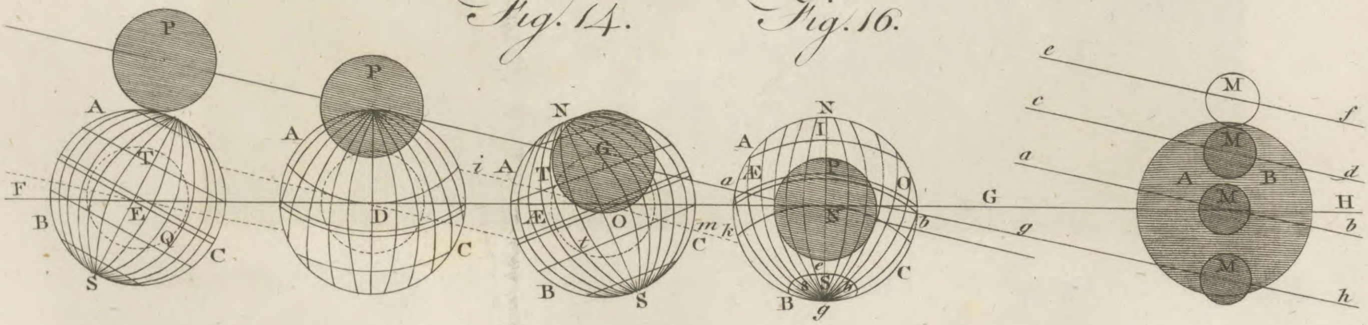


Fig. 14. Fig. 16.



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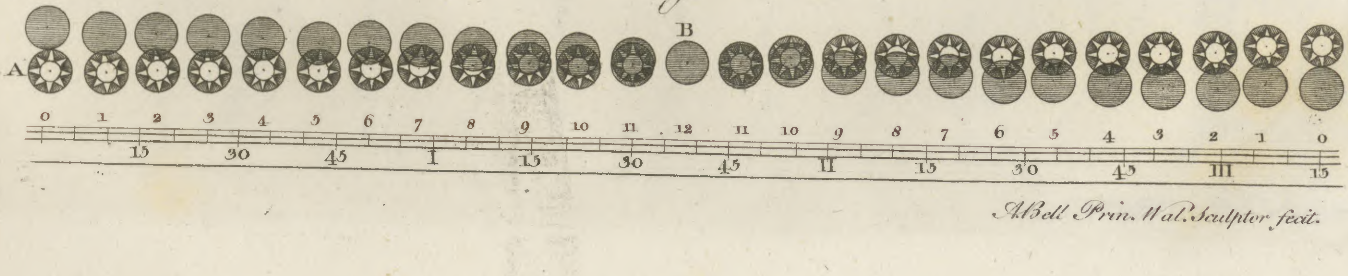


A. Bell Prin. Wal. Sculptor fecit.

Fig. 18.

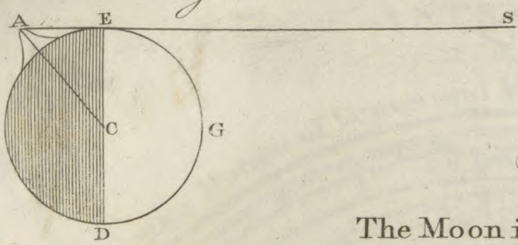


Fig. 19.

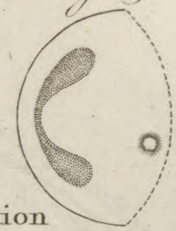


Fig. 20.

Fig. 17.

The Moon in her mean libration
with the Spots according to Riccioli, Cassini &c.

Fig. 21.

South

Fig. 22.

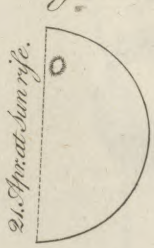


Fig. 23.

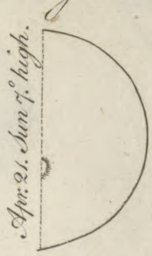


Fig. 24.

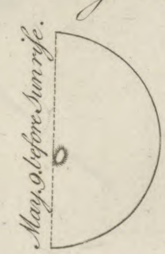
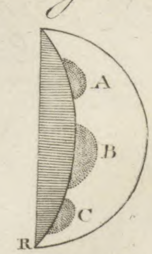


Fig. 25.

Fig. 26.



A. Bell Prin. Wal. Sculptor fecit.

Fig. 27.

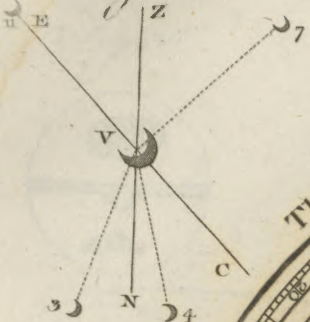


Fig. 40.

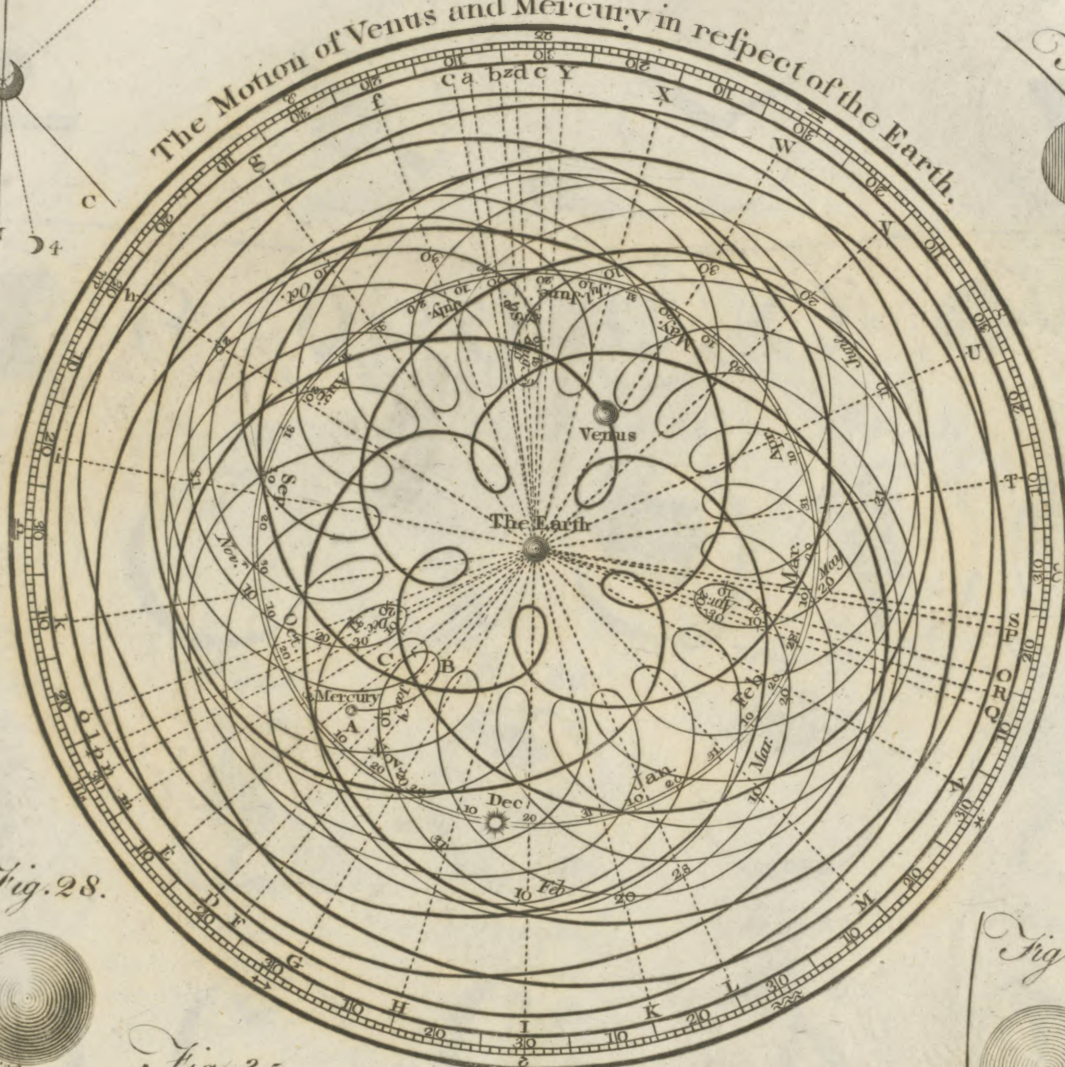


Fig. 34.

Fig. 28.

Fig. 32.

Fig. 35.

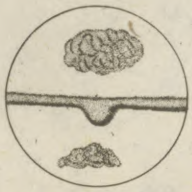
Fig. 31.

Fig. 29.

Fig. 30.

Fig. 33.

A Bell Prin. Wal. Sculptor fecit.

Fig. 36.

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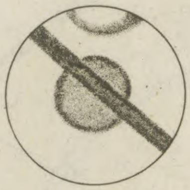
Fig. 38.

Fig. 39.

Fig. 40.


Fig. 41.

Fig. 42.

Fig. 43.

Fig. 44.

Fig. 45.

Fig. 46.

Fig. 47.

Fig. 48.

Fig. 49.

Fig. 50.

Fig. 51.

Fig. 52.

Fig. 53.

Fig. 54.

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Fig. 56.

Fig. 57.

Fig. 58.

Fig. 59.

Fig. 60.

Fig. 65.

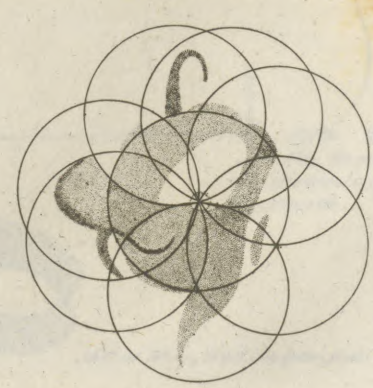
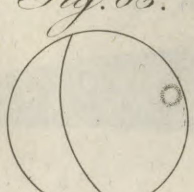



Fig. 61.

Fig. 62.

Fig. 63.

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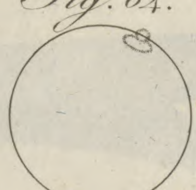
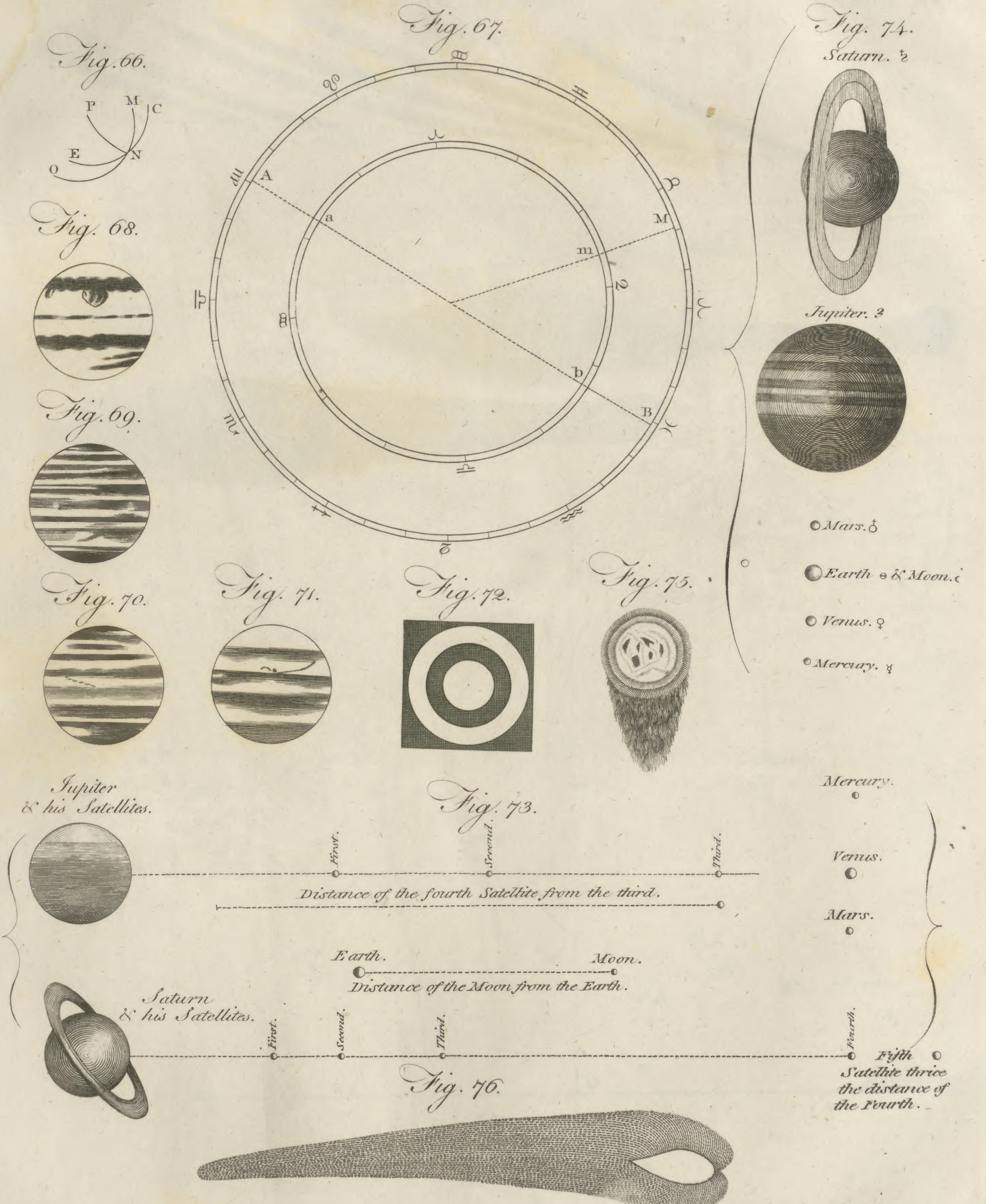
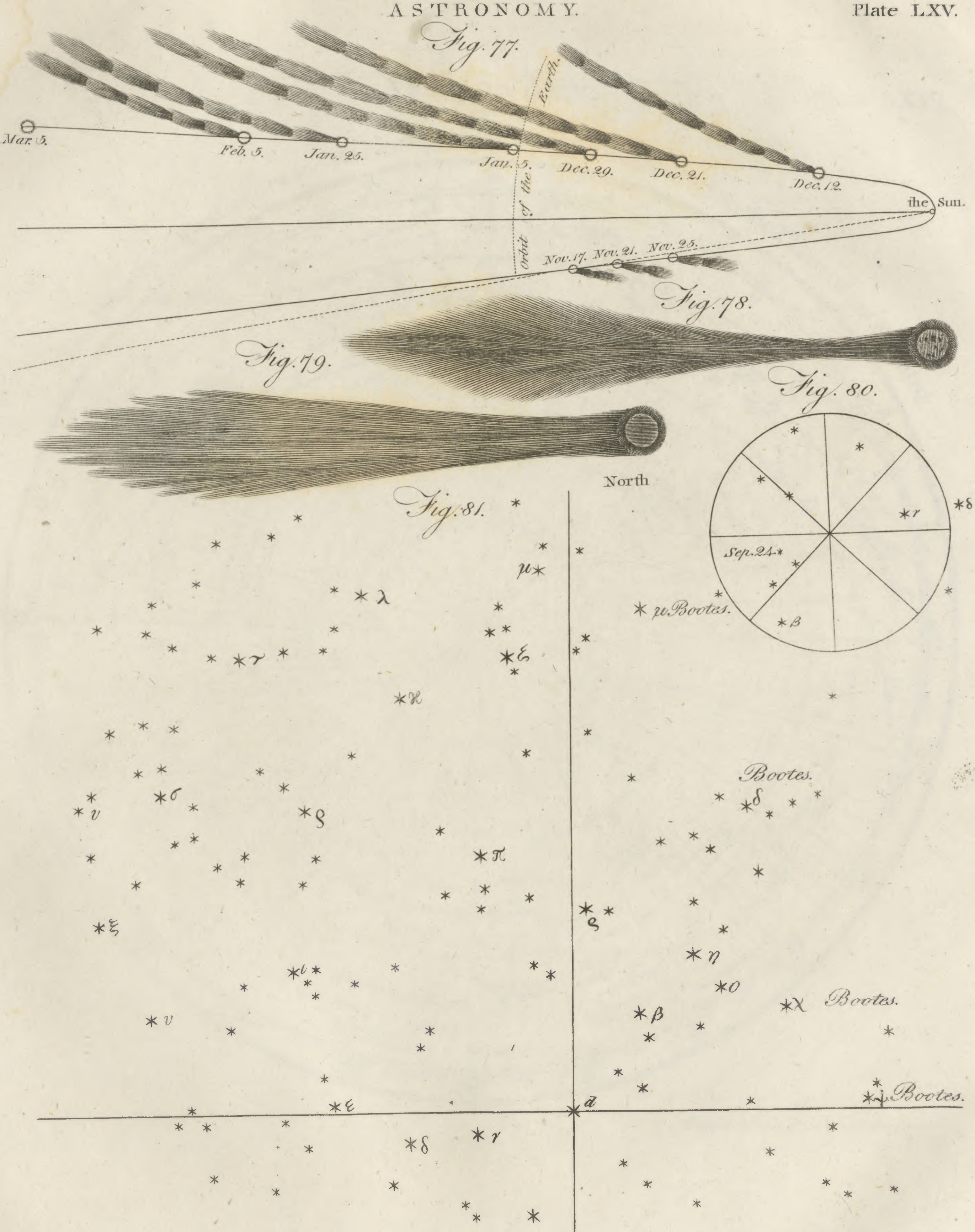


A. Bell Prin. Wal. Sculptor fecit.



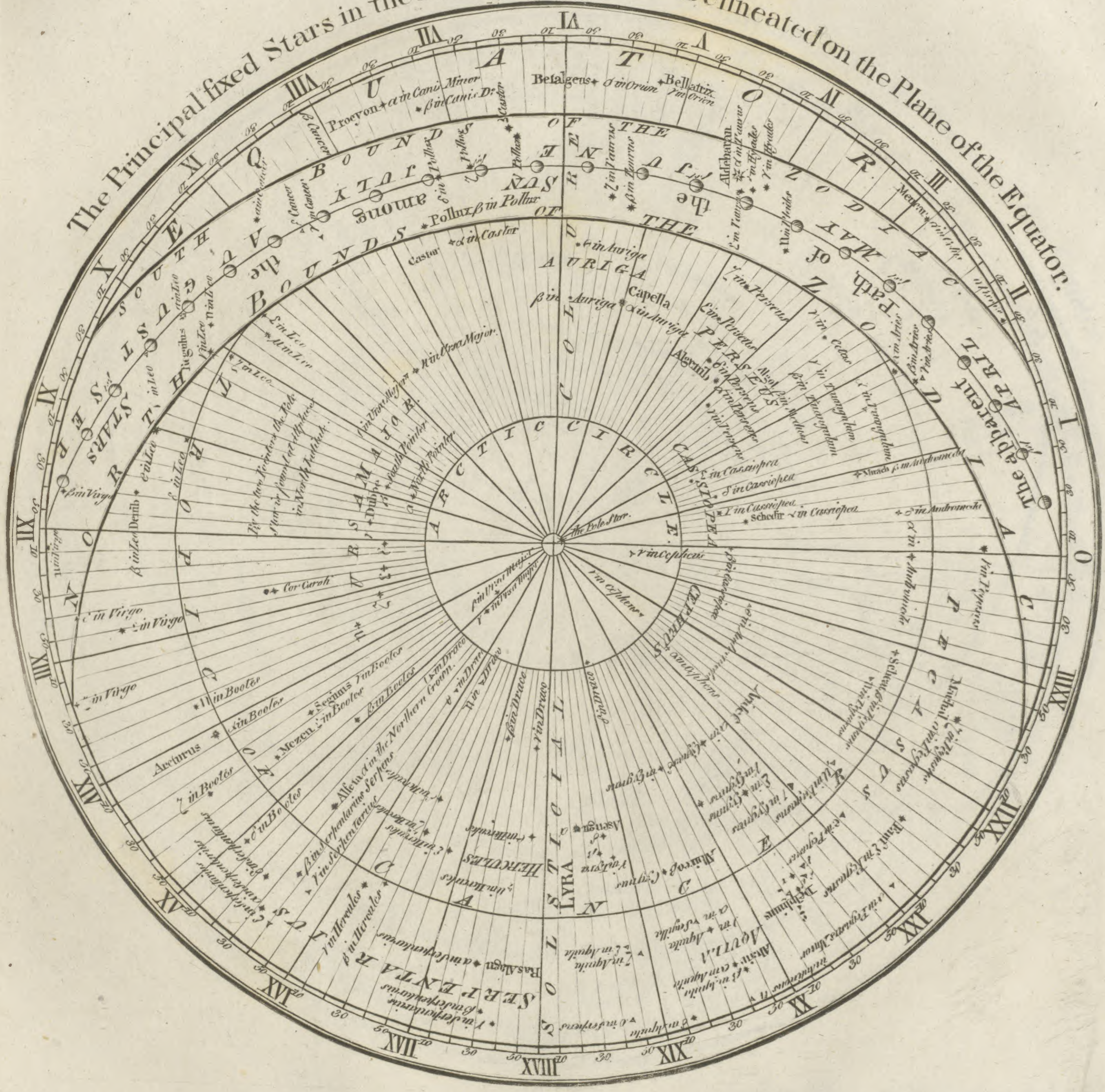
A.Bell Prin. Wal. Sculptor fecit.



Bell Prin. Wal. Sculptor fecit.

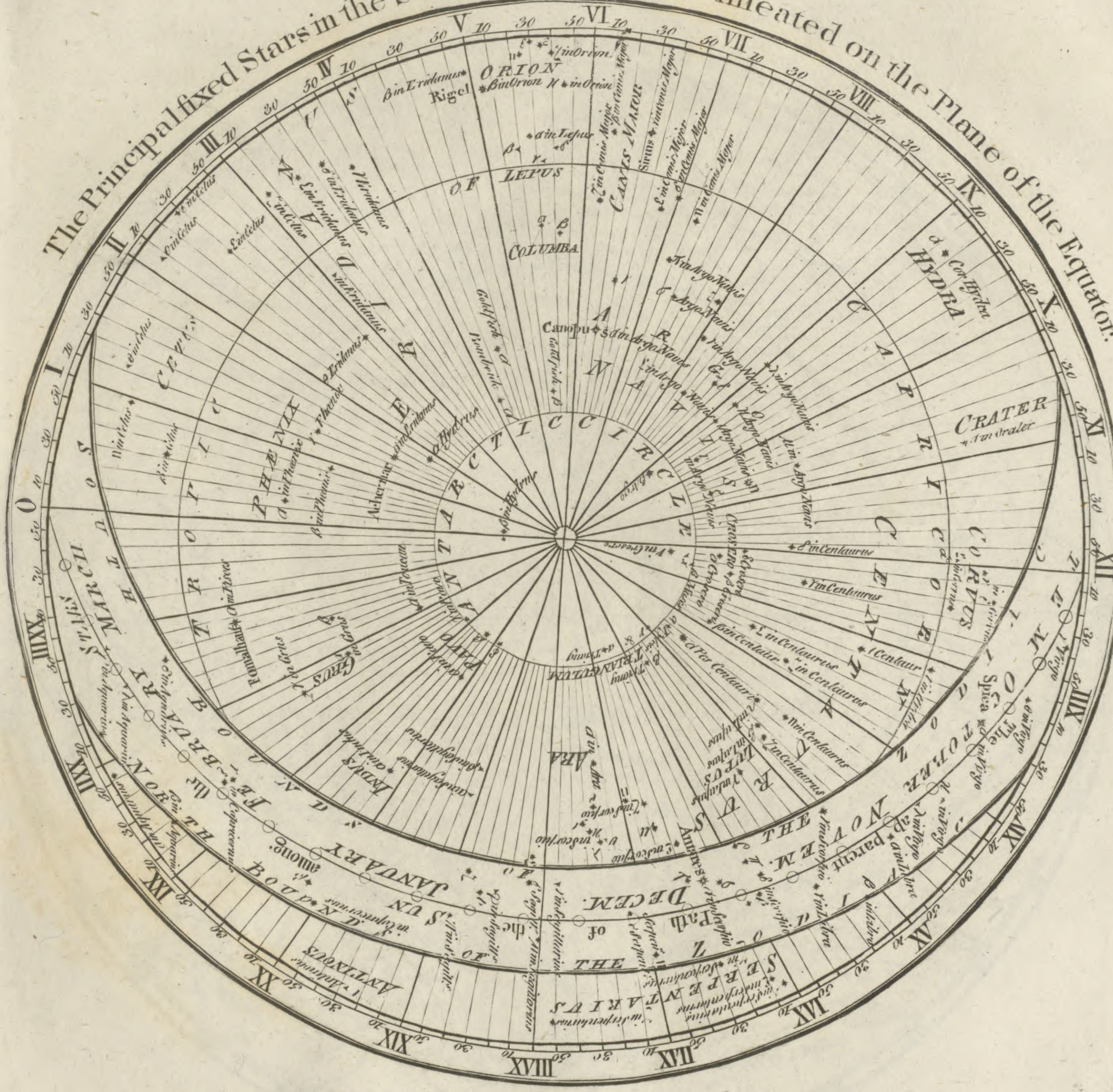
Fig. 82.

The Principal fixed Stars in the North Hemisphere Delineated on the Plane of the Equator.



A. Bell Prin. Wal. Sculptor fecit.

The Principal fixed Stars in the South Hemisphere Delineated on the Plane of the Equator.



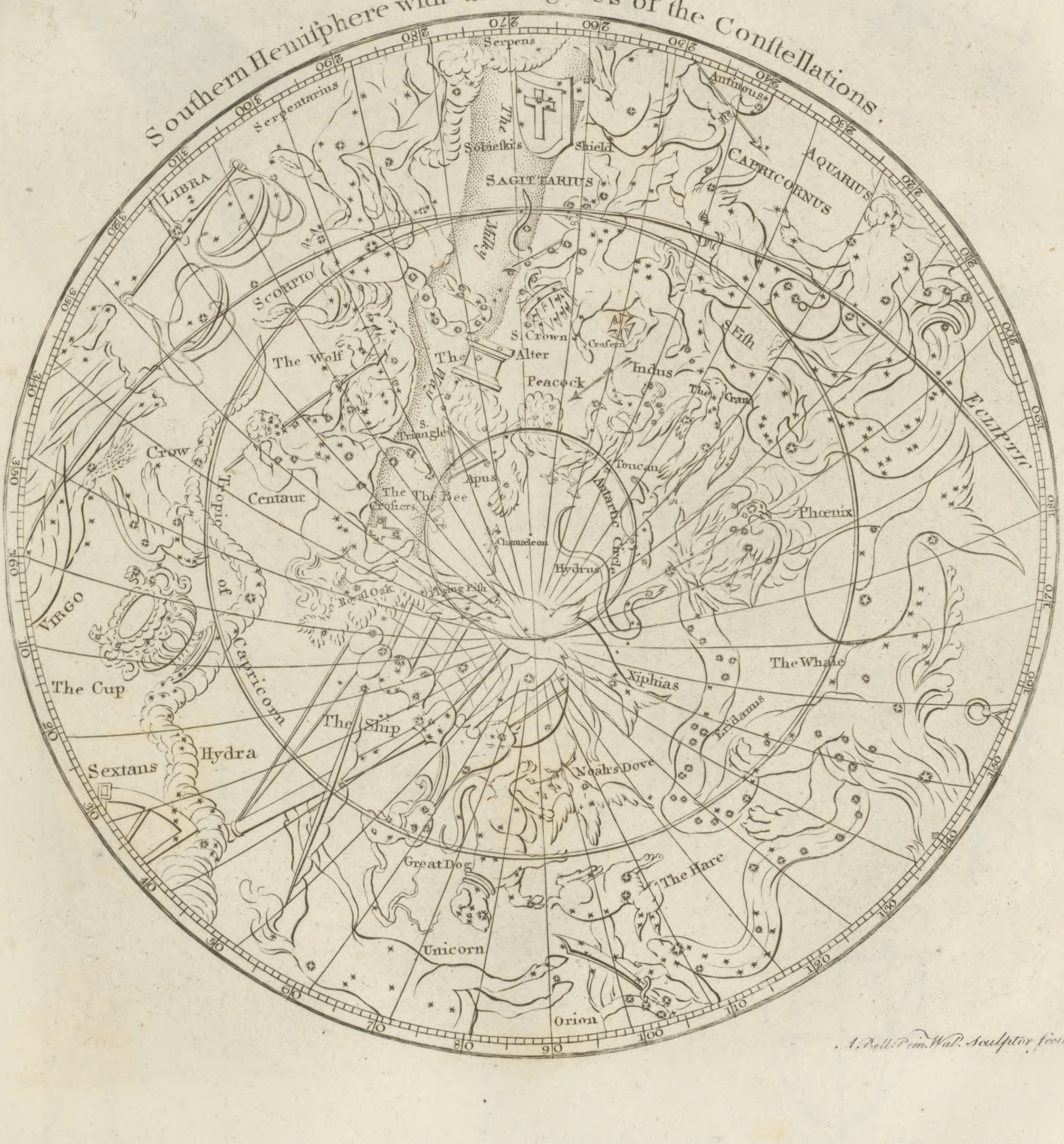
A. Bell. Prin. Wal. Sculptor fecit.

Fig. 82 b.

A. Bell, Prin. Wal. Sculptor, fecit.

Fig. 82 c.

Southern Hemisphere with the Figures of the Constellations.



A. Bell. Pen. Wal. Sculptor fecit.

Fig. 83.

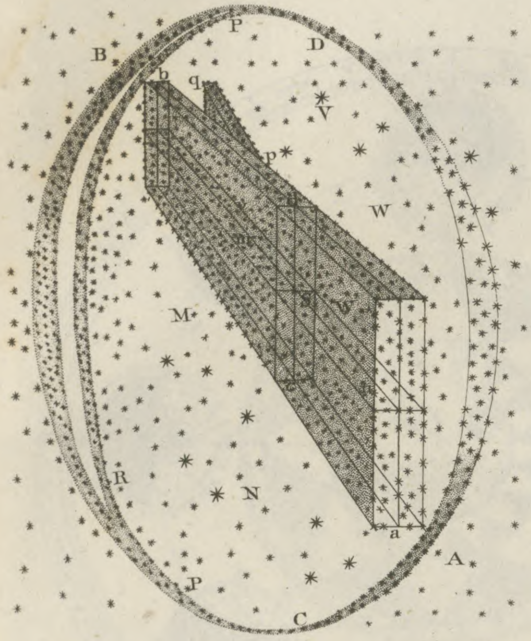


Fig. 84.

Fig. 86.

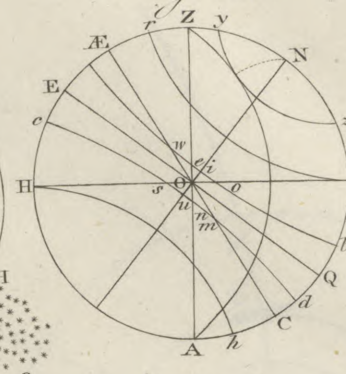


Fig. 85.

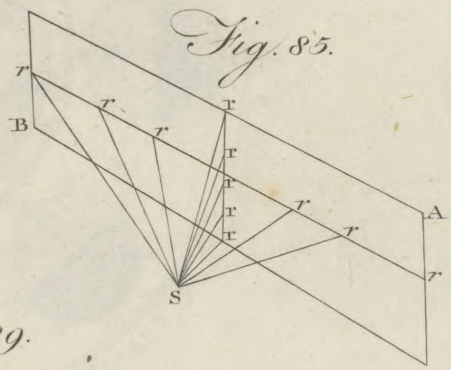


Fig. 87.

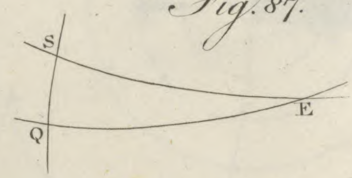


Fig. 88.

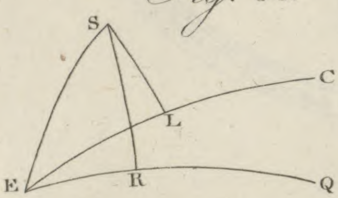


Fig. 89.

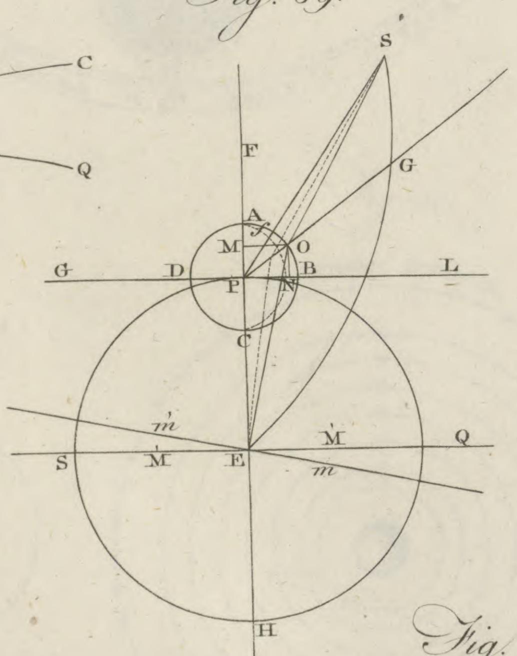


Fig. 90.

Fig. 91.

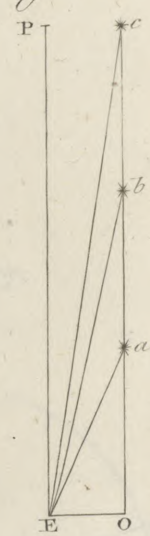


Fig. 92.

Fig. 93.

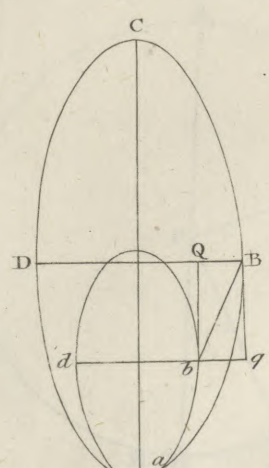
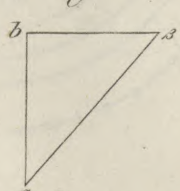
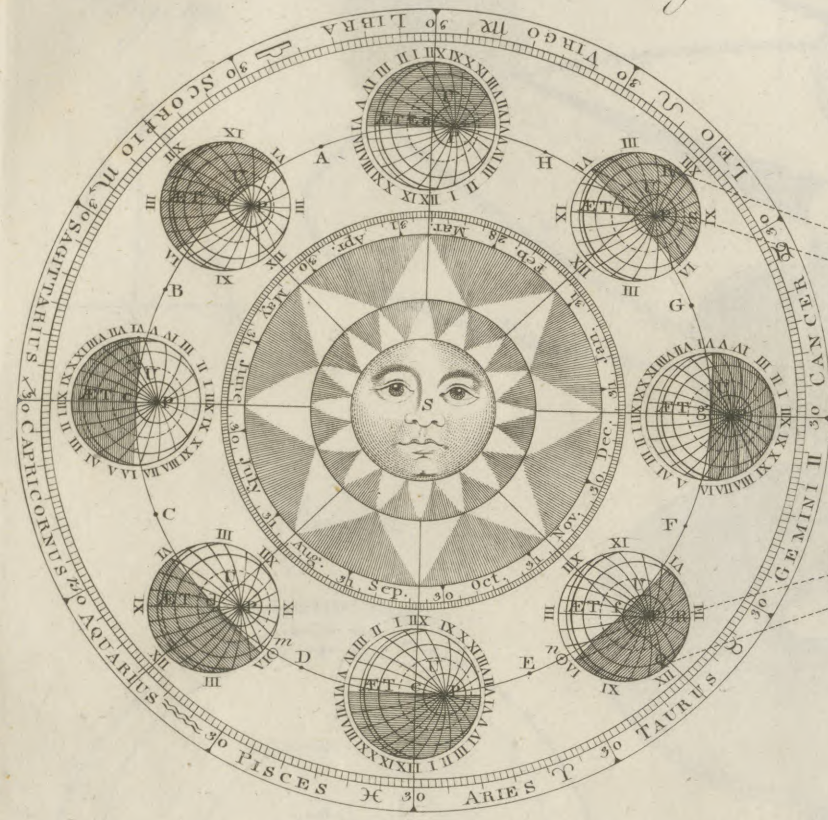


Fig. 94.



A. Bell Prin. Wal. Sculptor fecit.

Fig. 96. & 103.



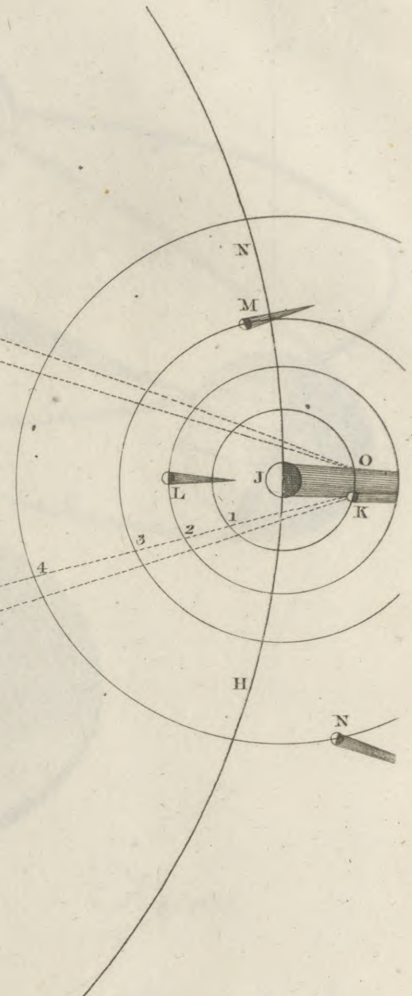


Fig. 98.

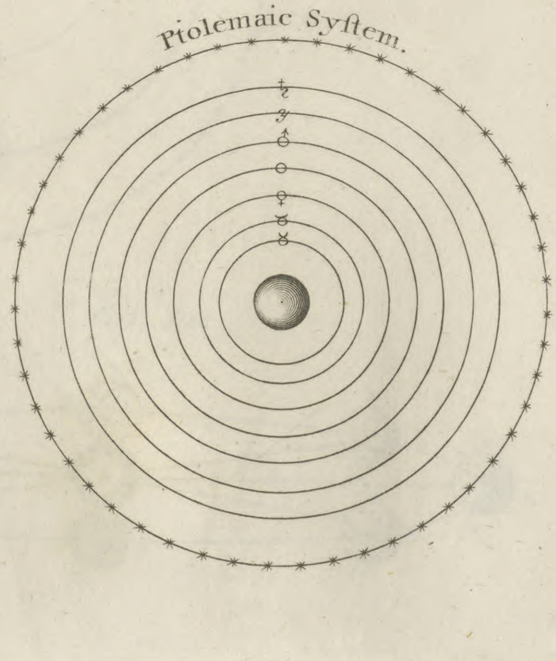


Fig. 95.

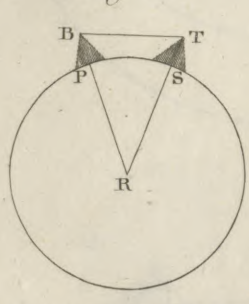


Fig. 97.

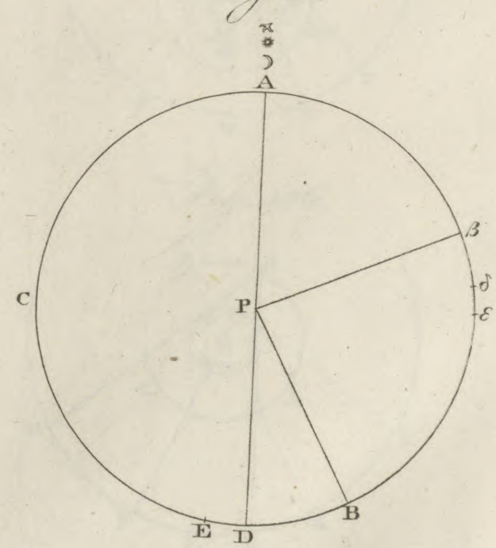
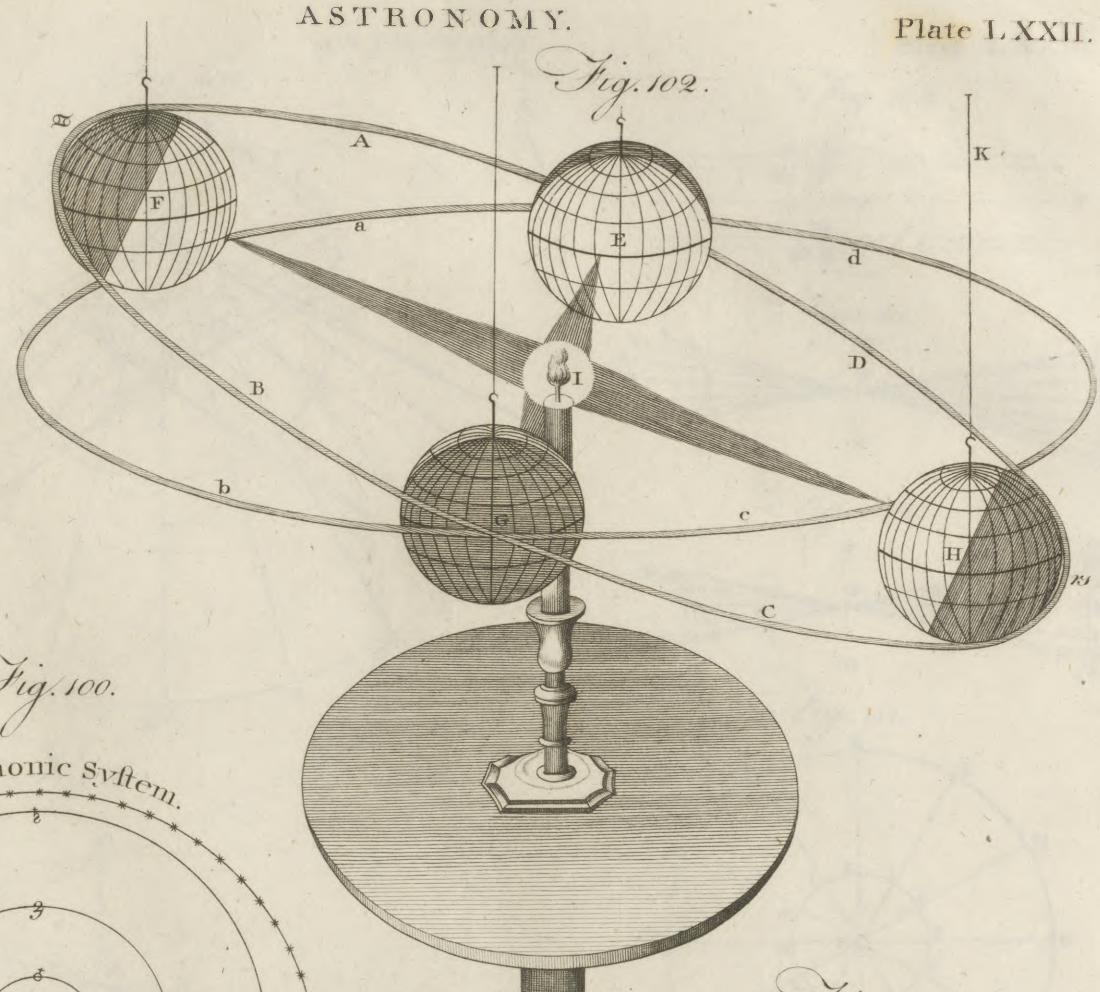


Fig. 102.



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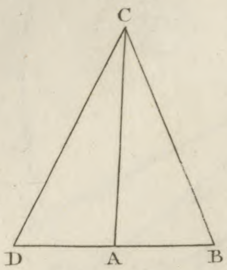


Fig. 100.

Tychonic System.

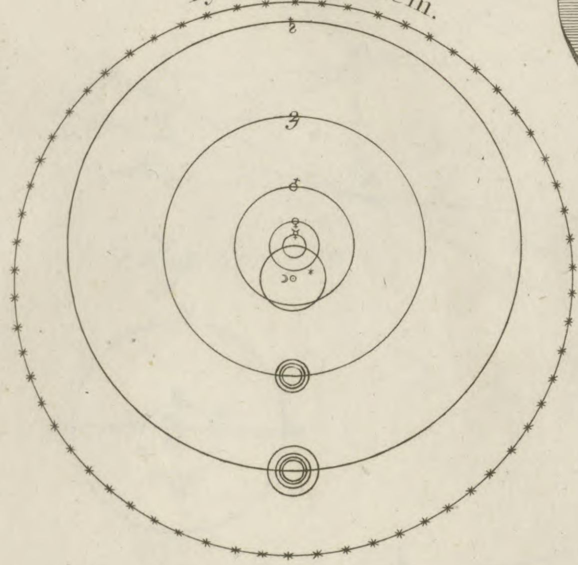


Fig. 105.

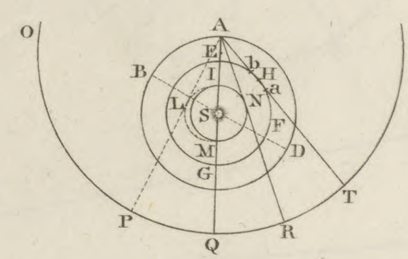


Fig. 104.

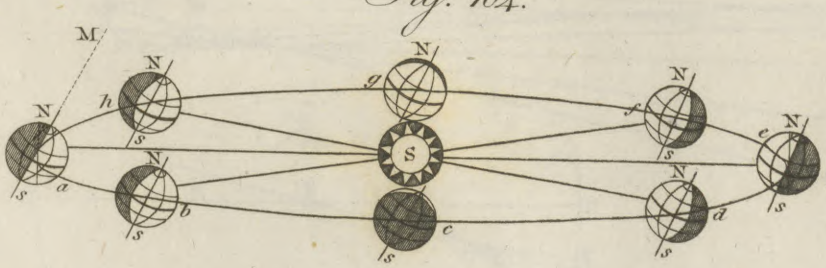
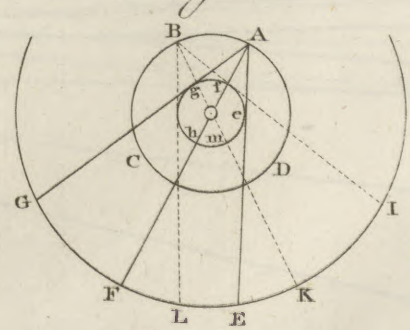


Fig. 106.



A. Bell Prin. Wal. Sculptor fecit.

Fig. 107.

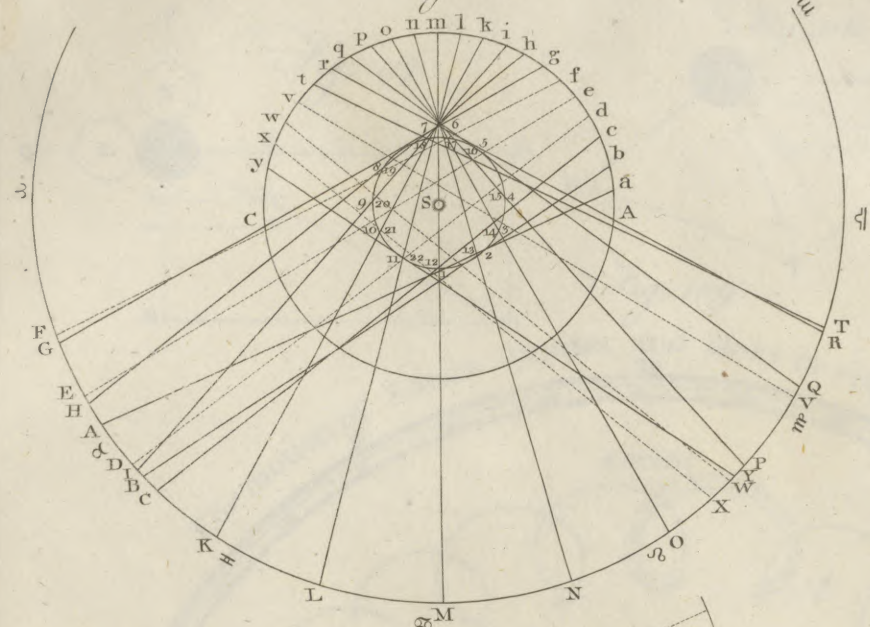


Fig. 108.

Fig. 111.

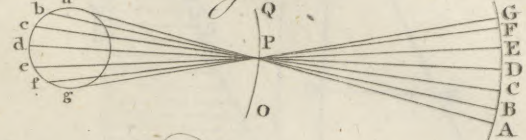


Fig. 112.

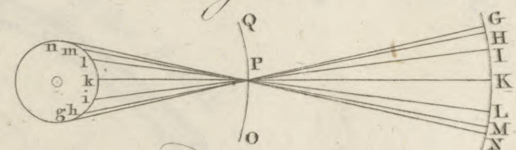


Fig. 114.

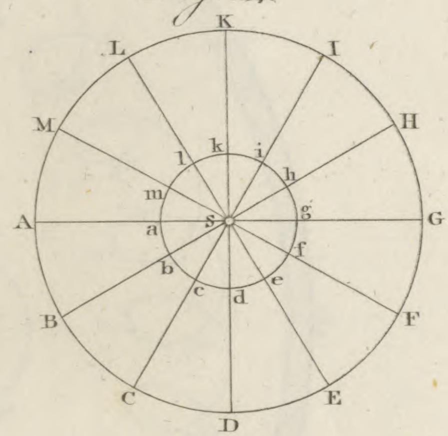


Fig. 110.

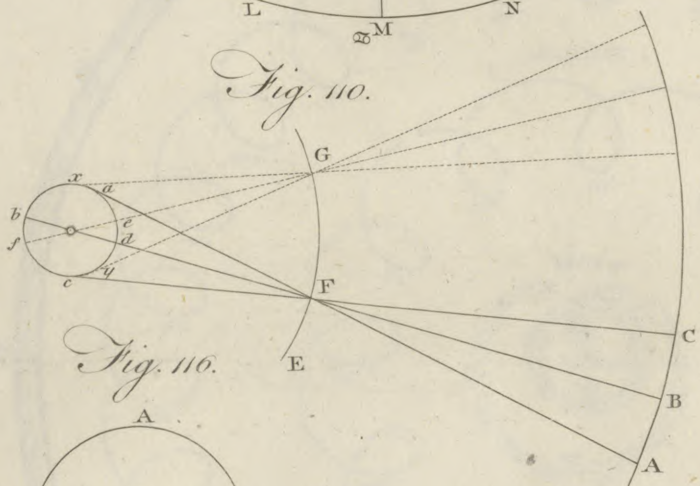


Fig. 116.

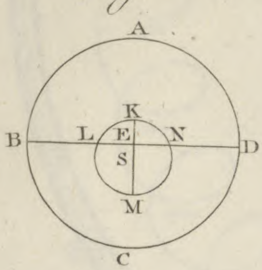


Fig. 113.

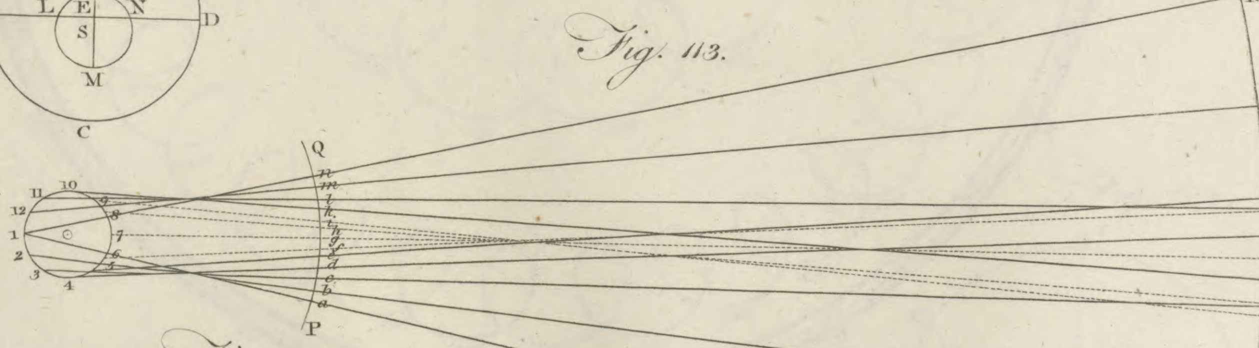
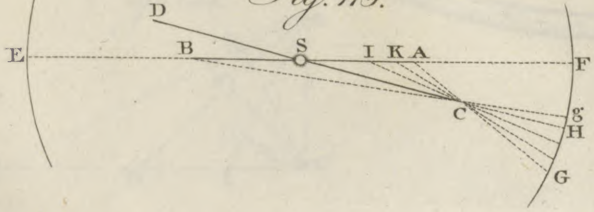


Fig. 115.



A. Bell Prin. Wal. Sculptor fecit.

Fig. 117.

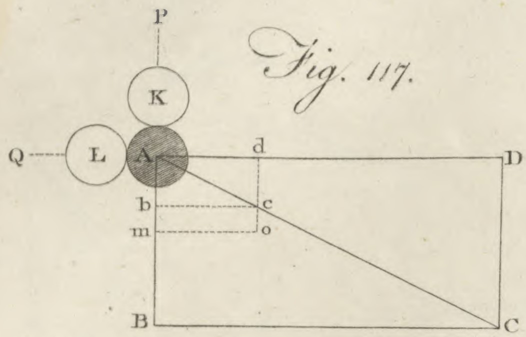


Fig. 118.

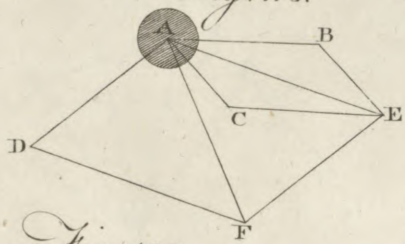


Fig. 109.

Fig. 119.

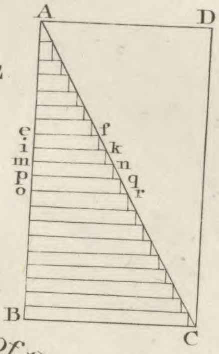
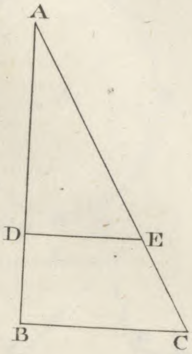


Fig. 120.



The motion of Saturn Jupiter and Mars in respect of the Earth.

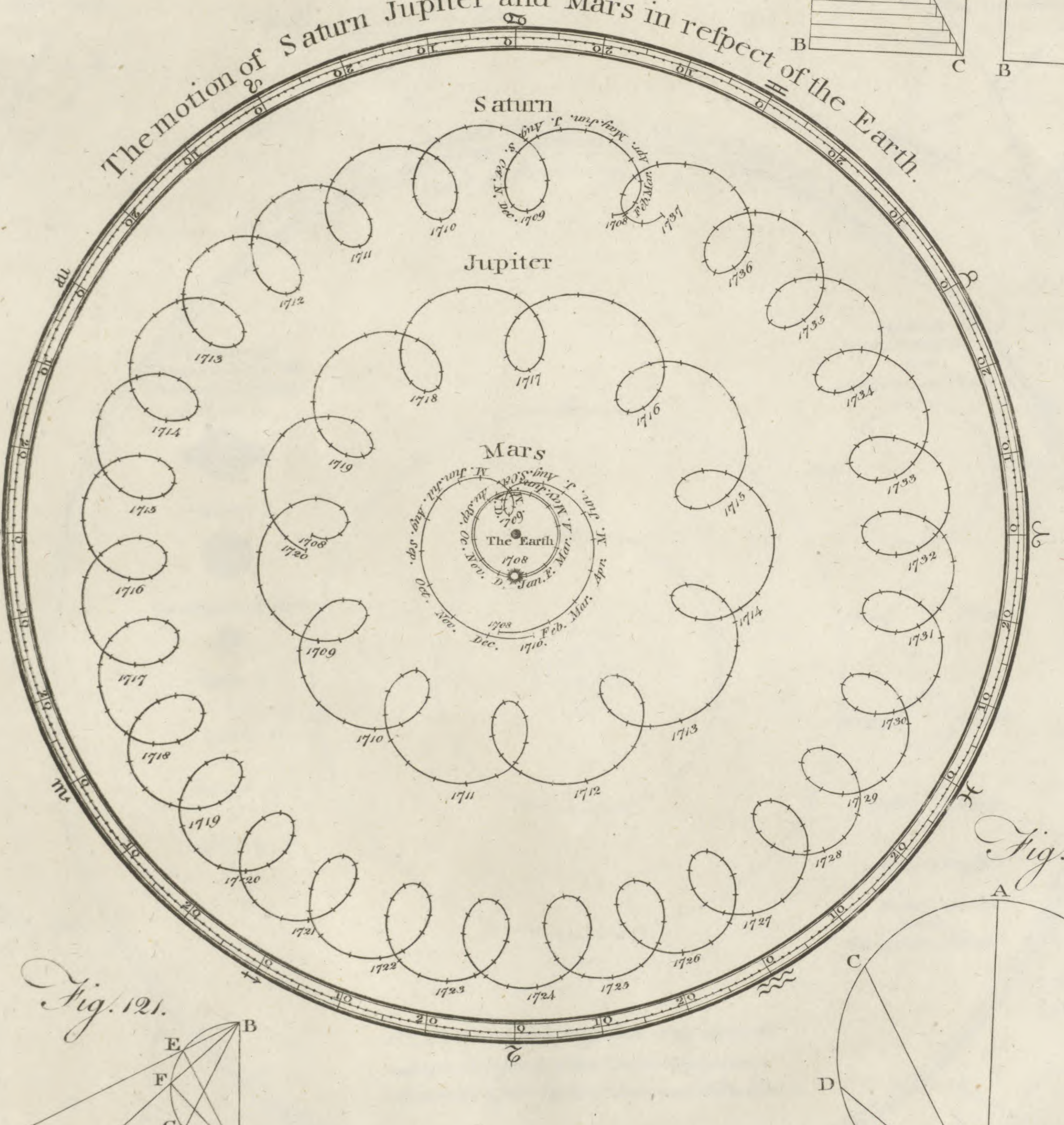


Fig. 121.

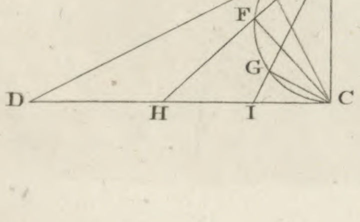
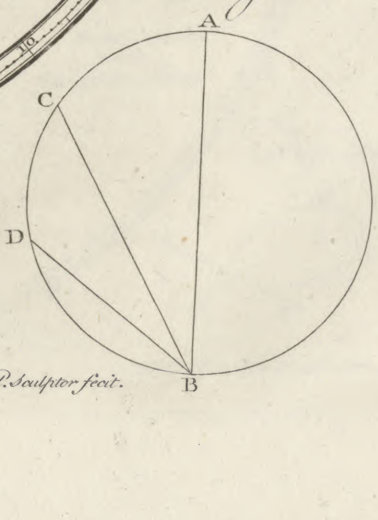
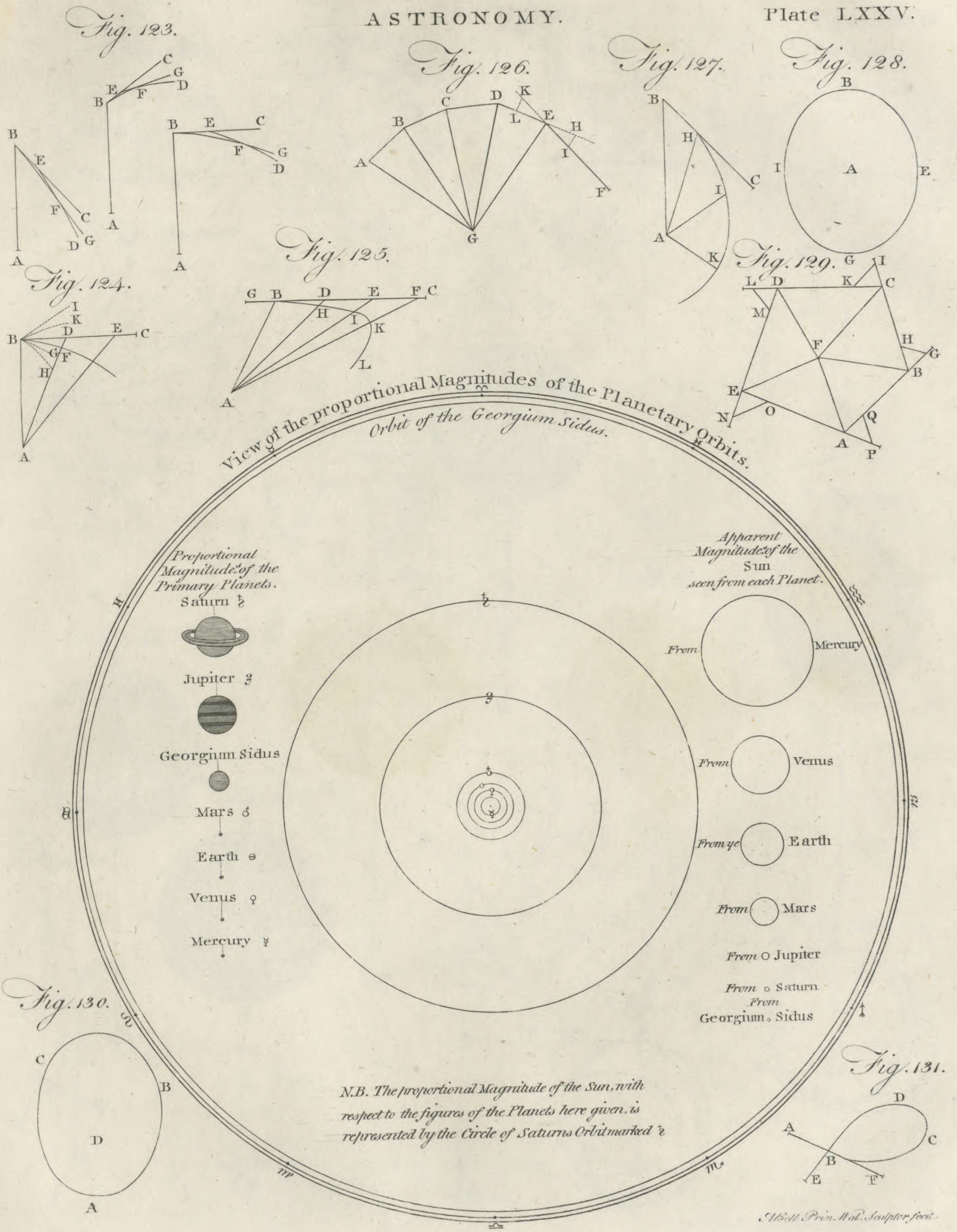


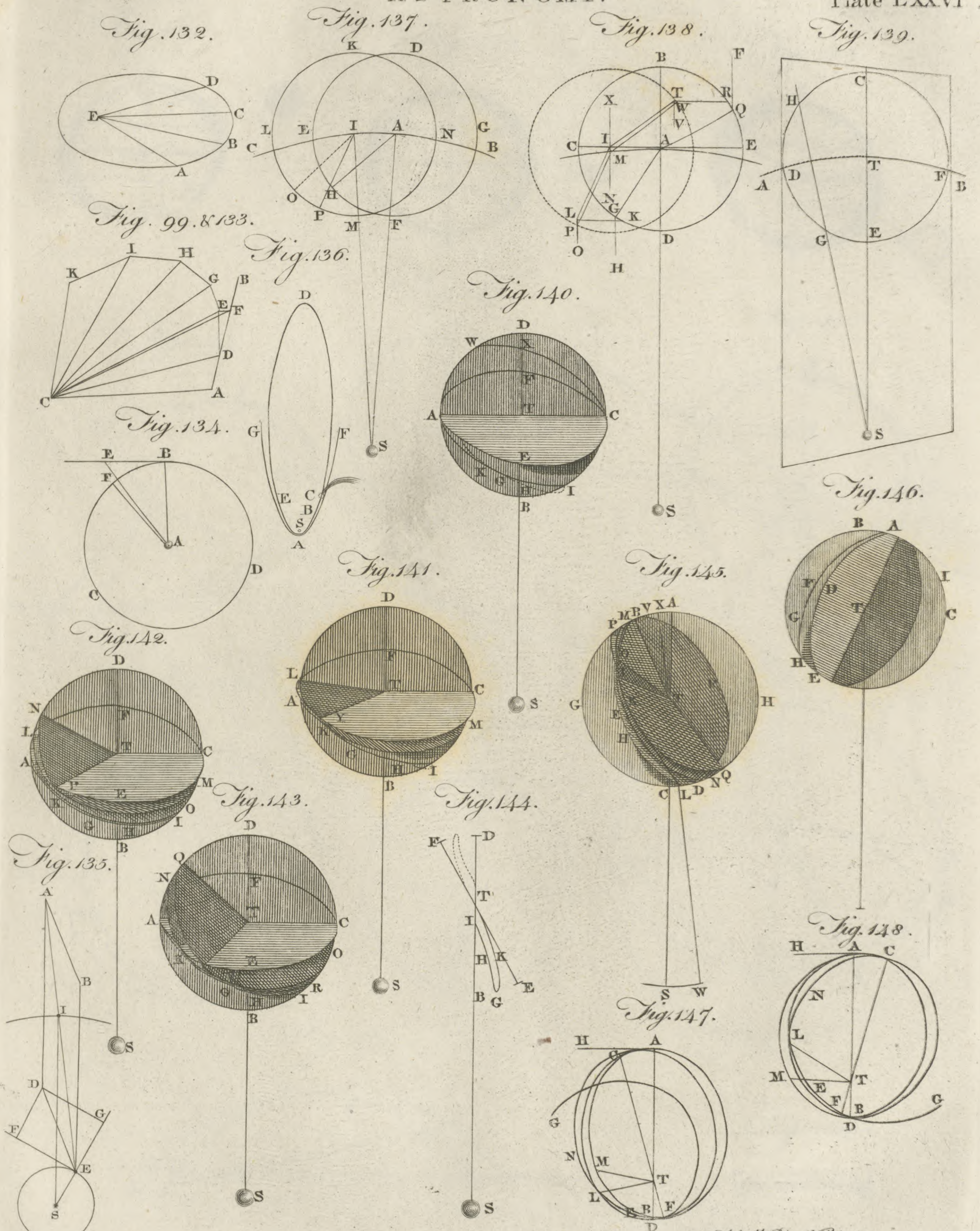
Fig. 122.



A. Bell Prin. Wal. Sculptor fecit.

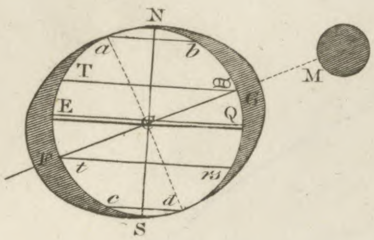


A. Bell Prin. Wal. Sculptor fecit.



A. Bell Prin. Wal. Sculptor fecit.

Fig. 151.



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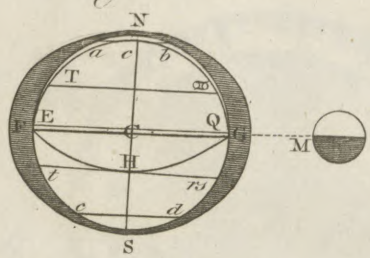

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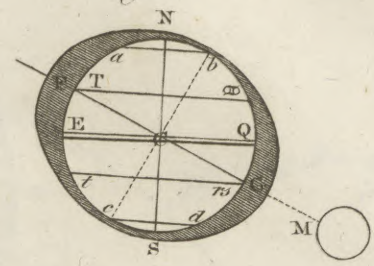
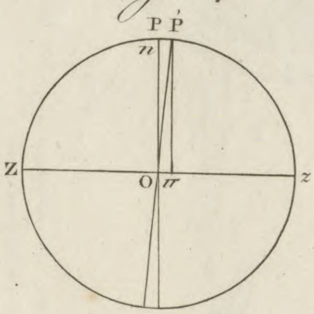


Fig. 157.



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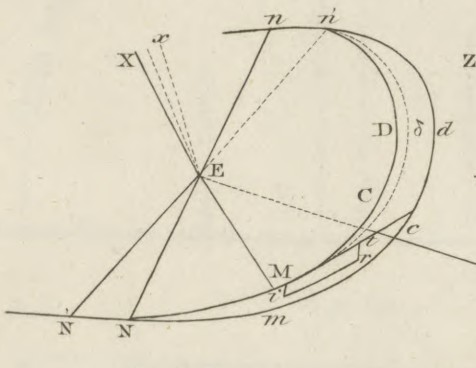

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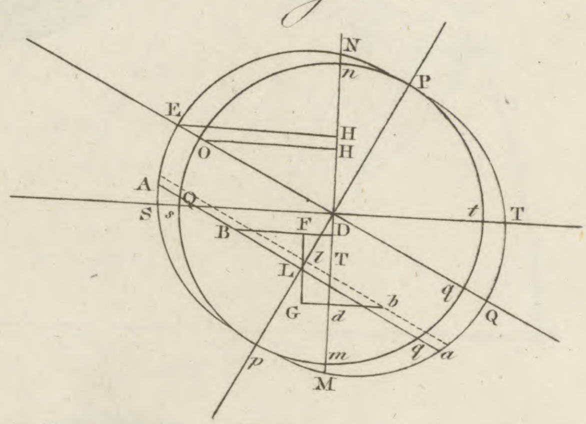


Fig. 156.

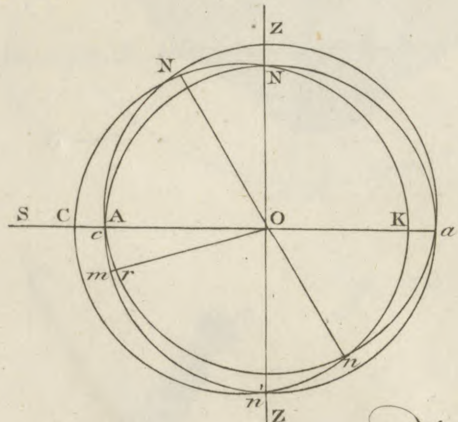


Fig. 158.

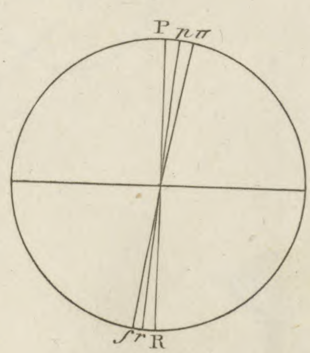


Fig. 159.

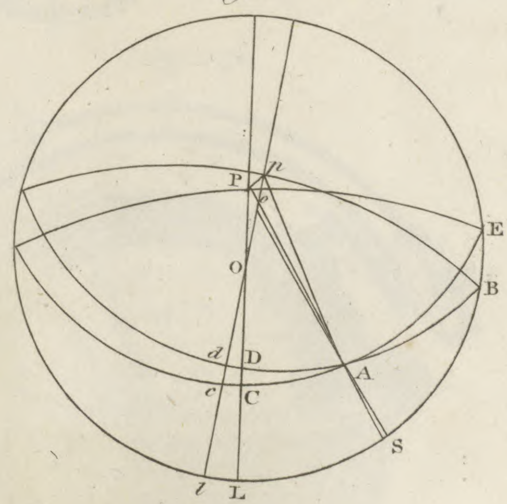


Fig. 160.

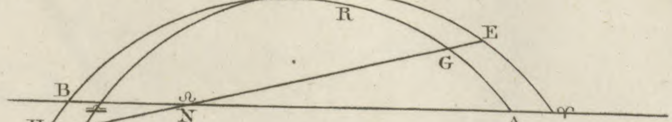
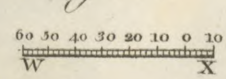


Fig. 159. a.



A. Bell Prin. Wal. Sculptor fecit.

Fig. 158 a.

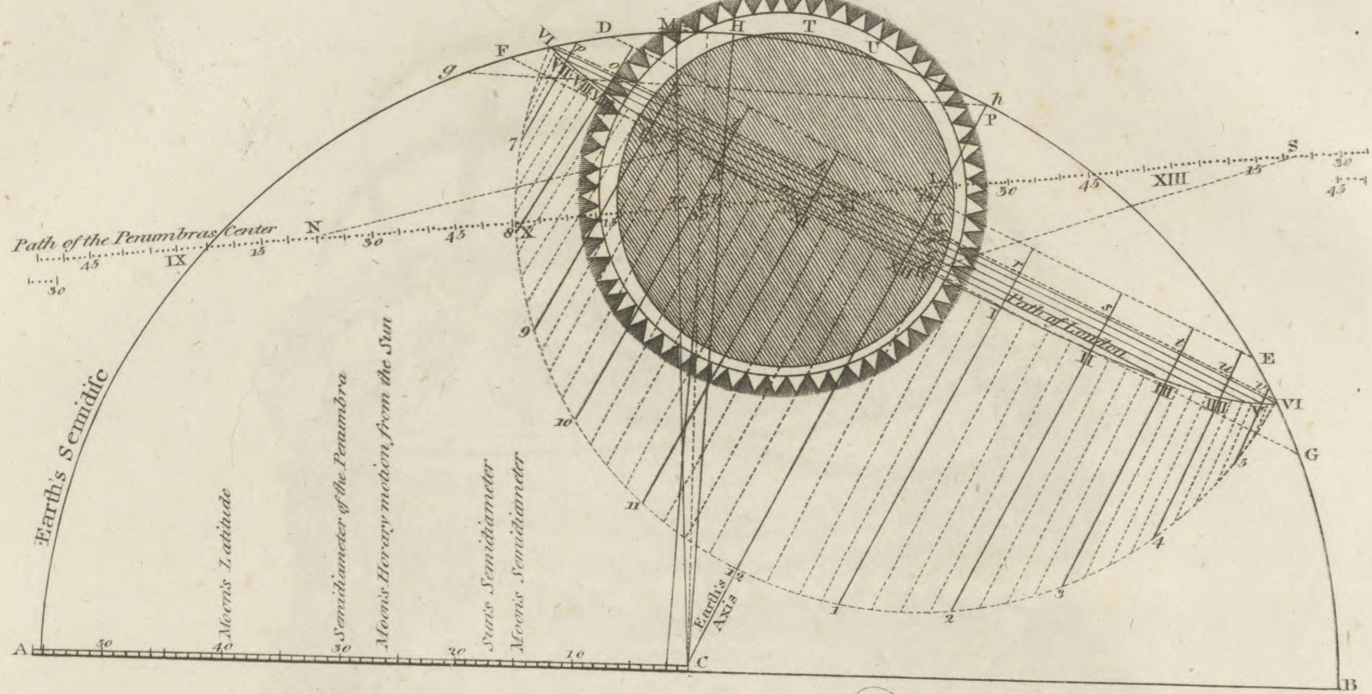


Fig. 160 a.

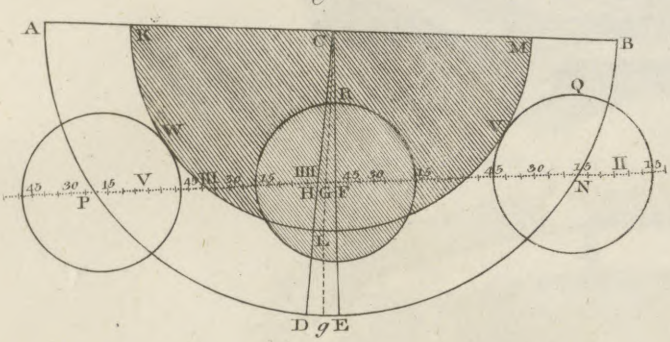


Fig. 163.

Fig. 170.

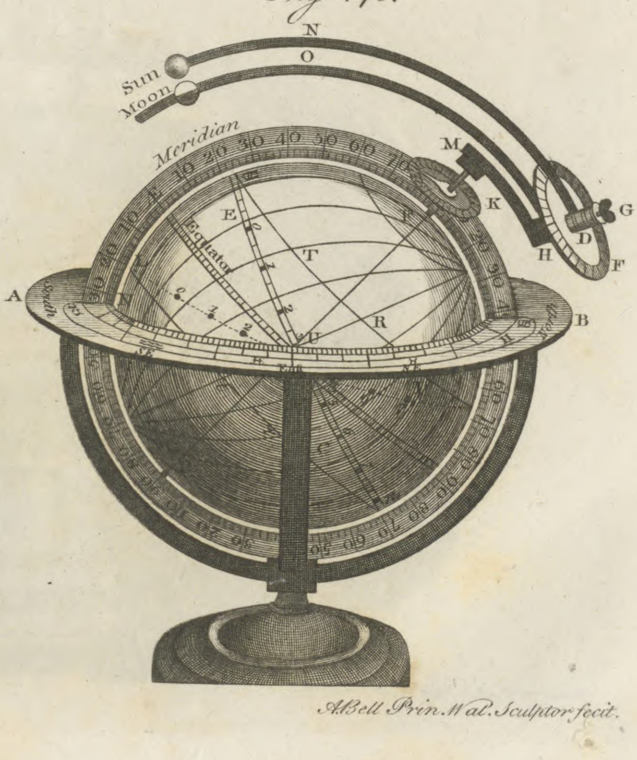
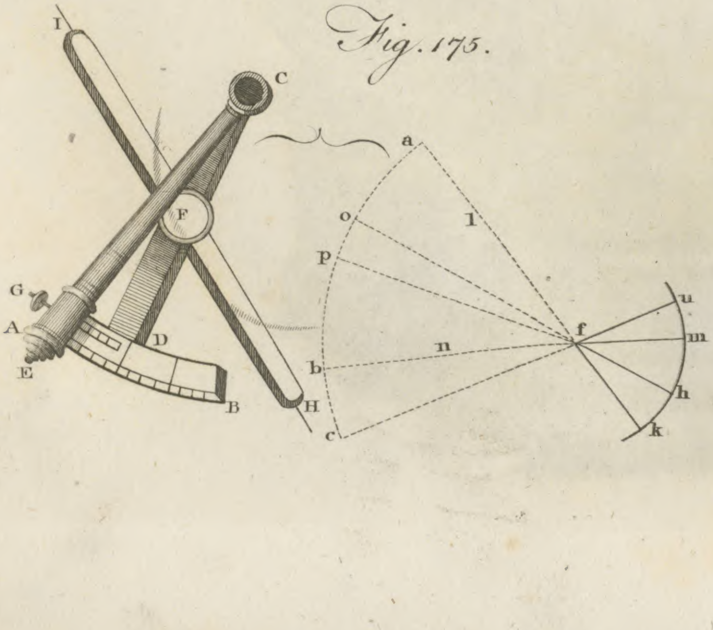


Fig. 175.



A. Bell Prin. Wal. Sculptor fecit.

Fig. 161. The GRAND ORRERY by Rowley.

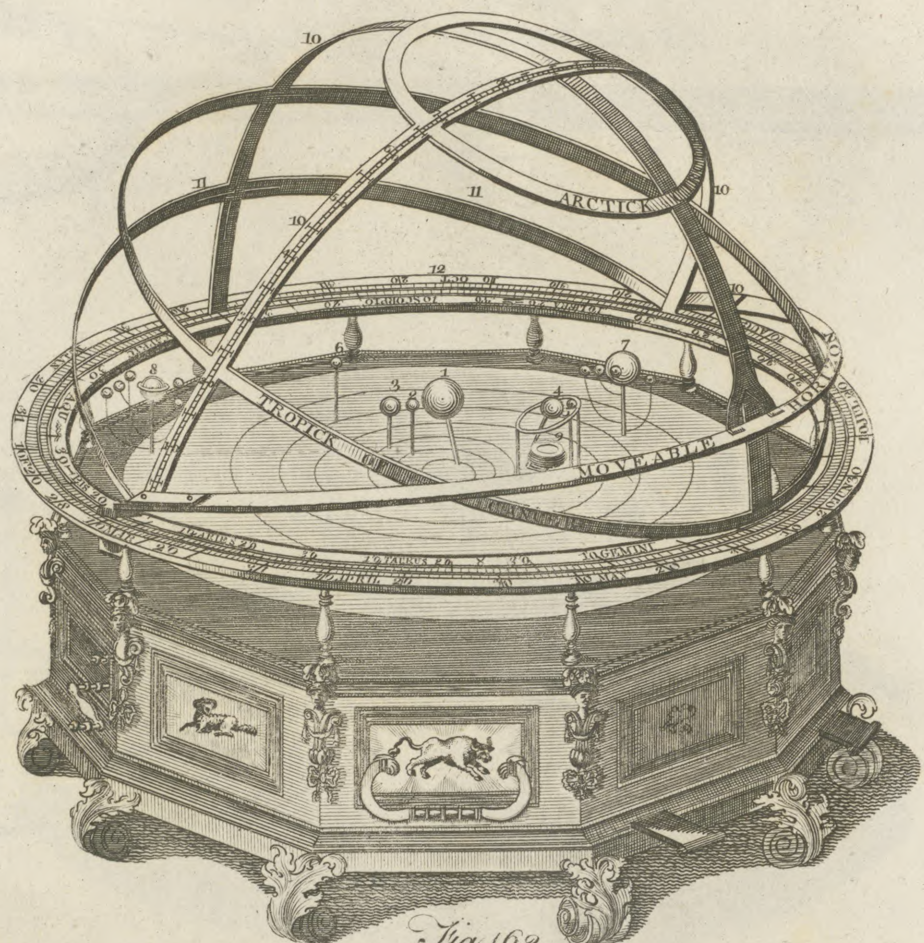
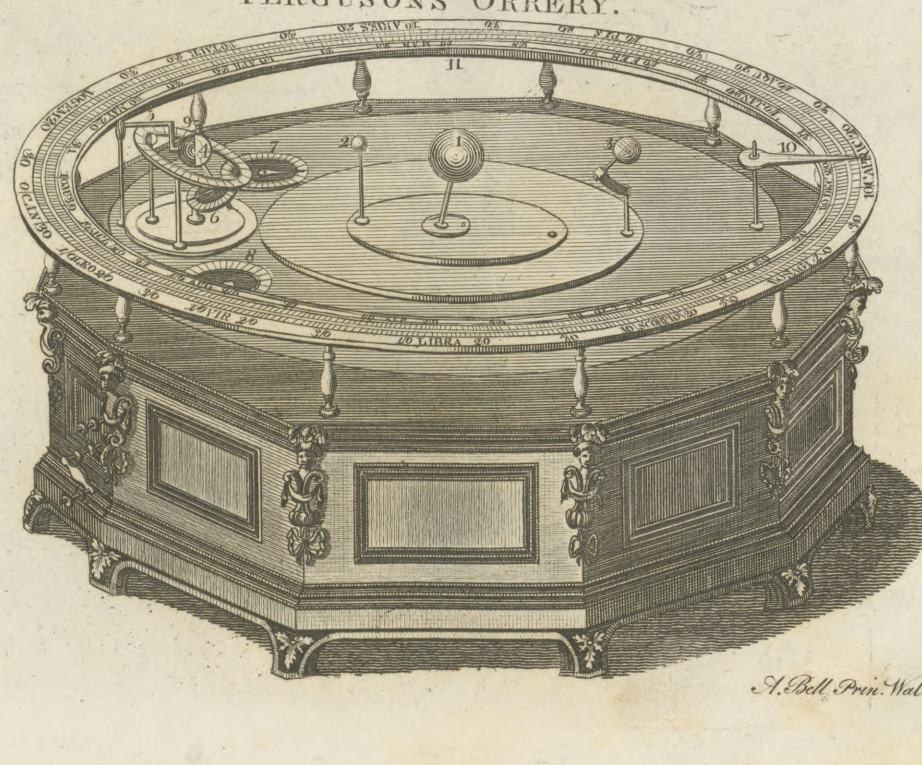


Fig. 162.
FERGUSONS ORRERY.



A. Bell Prin. Wal. Sculptor fecit.

Fig. 171.
TRAJECTORIUM LUNARE.

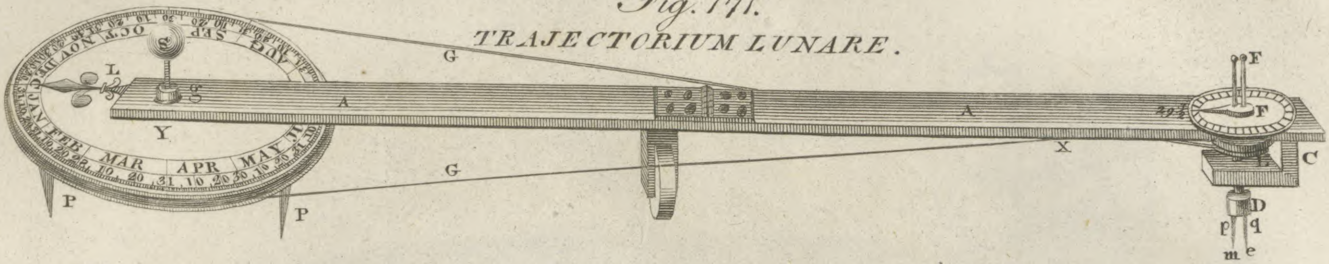
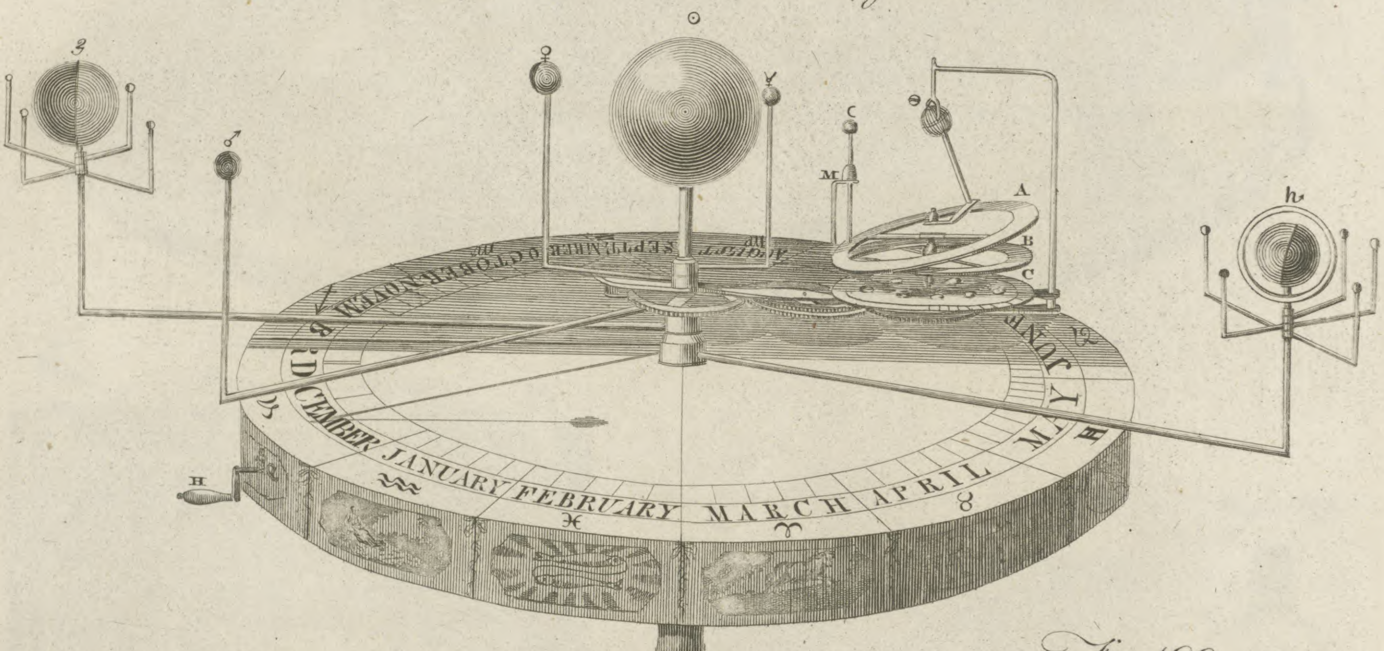


Fig. 164. PLANETARIUM *by Jones.*



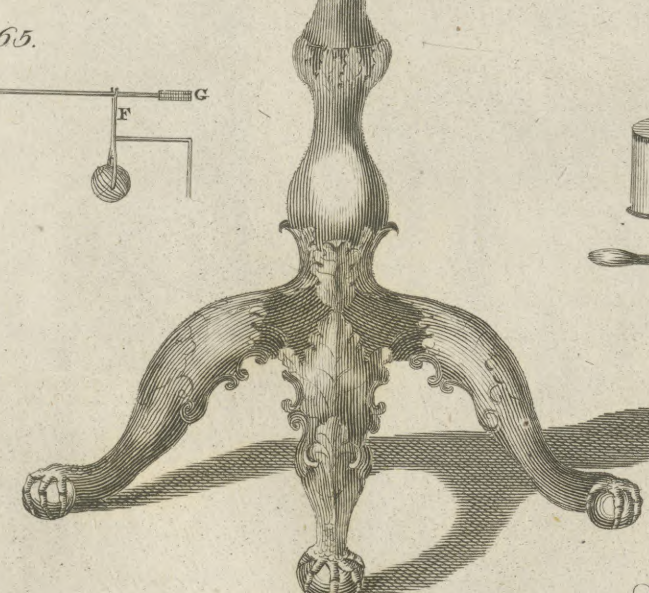


Fig. 165.

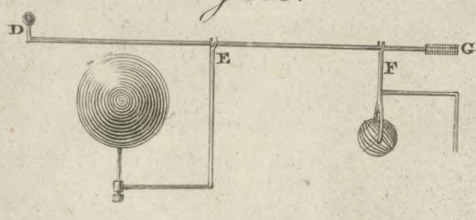
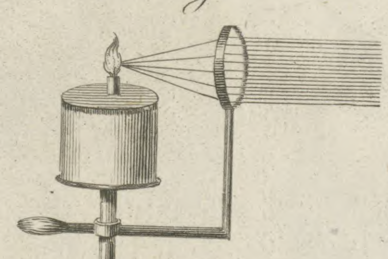


Fig. 166.



A. Bell Prin. Wal. Sculptor fecit.

Fig. 167.

Mechanical Paradox.

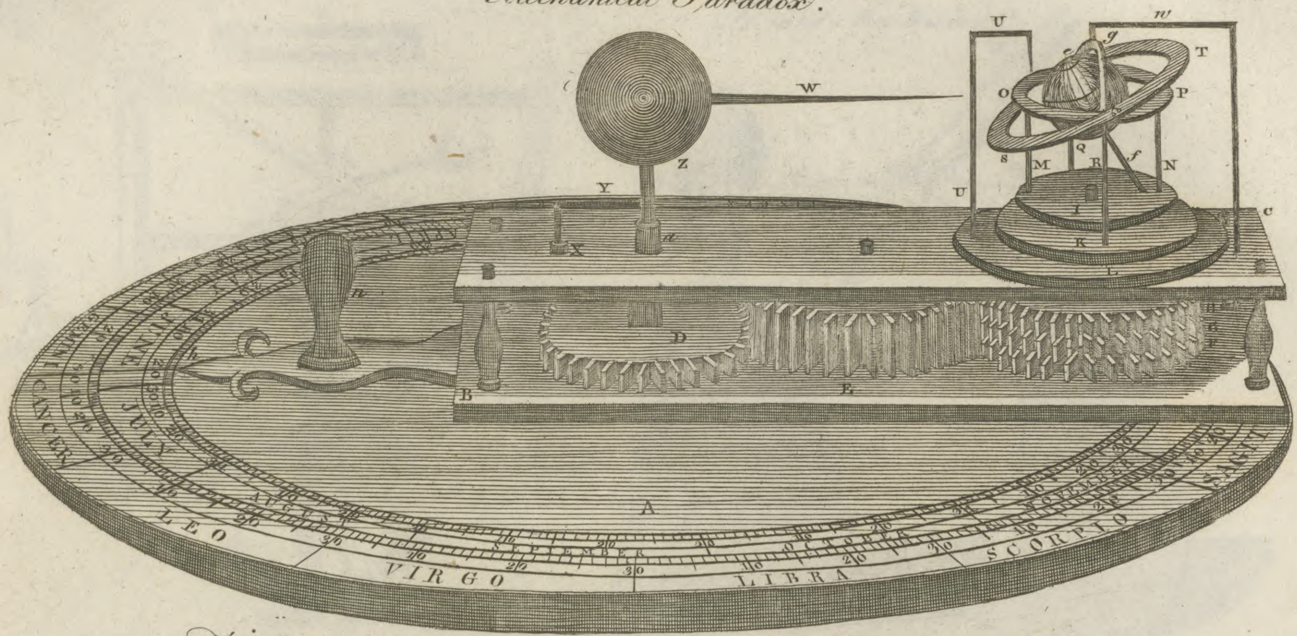


Fig. 172.

Mural Quadrant.

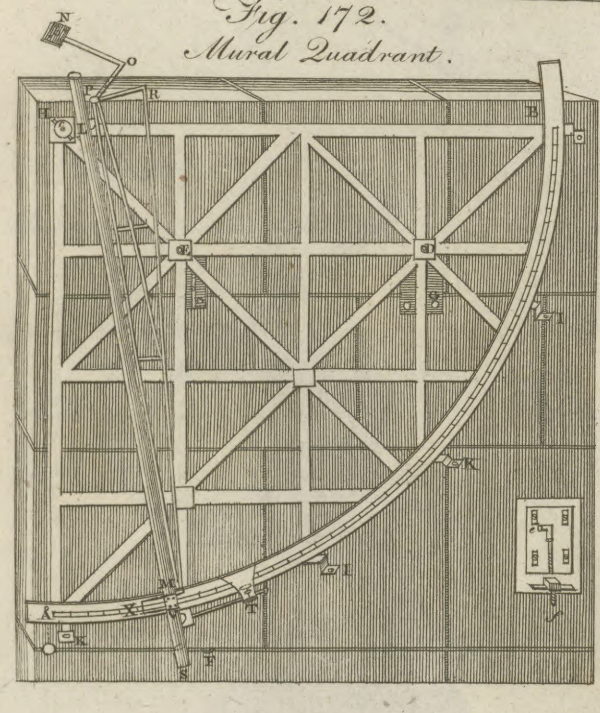


Fig. 173.

Fig. 168.

Cometarium.

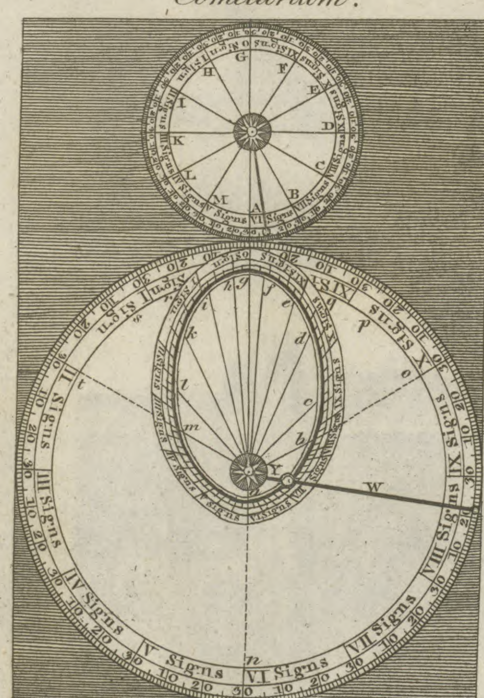
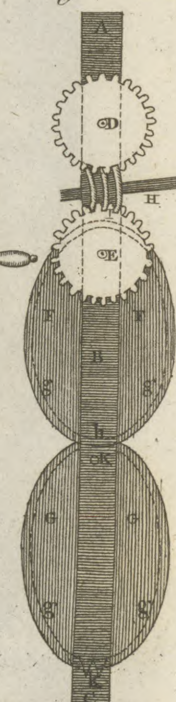


Fig. 169.



A. Bell Prin. Wal. Sculptor fecit.

Fig. 174.
Portable Astronomical Quadrant.

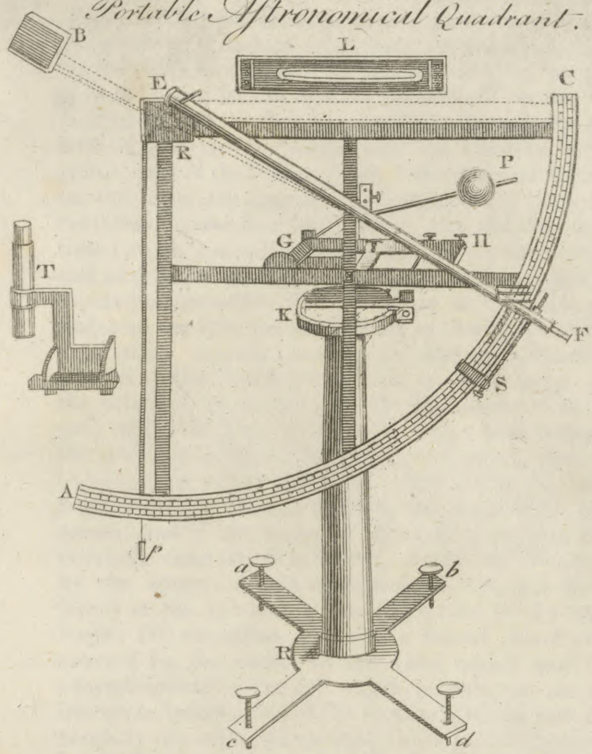


Fig. 176.
Transit Instrument.

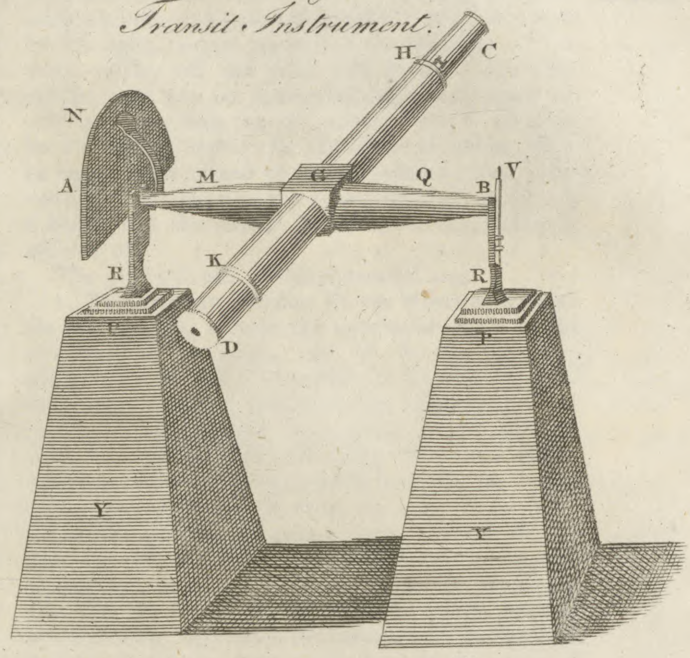


Fig. 178.

Compound Transit Instrument.

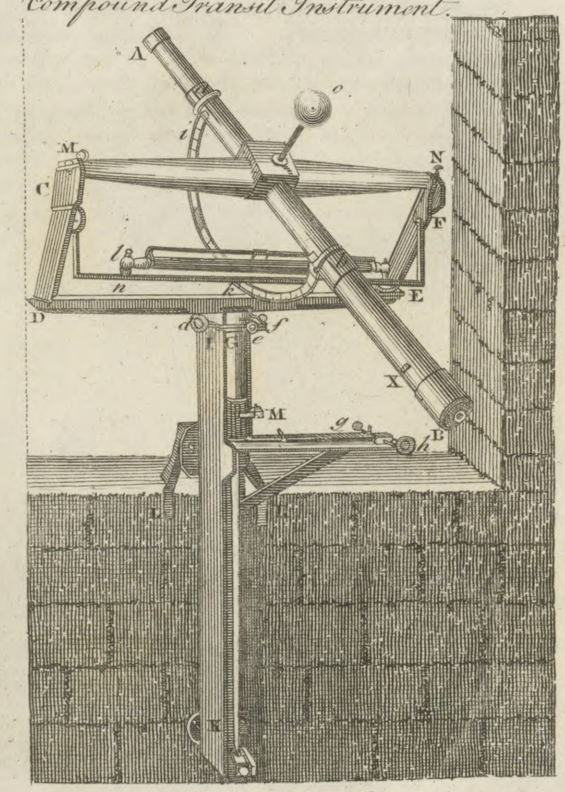


Fig. 179.
Universal Equatorial.

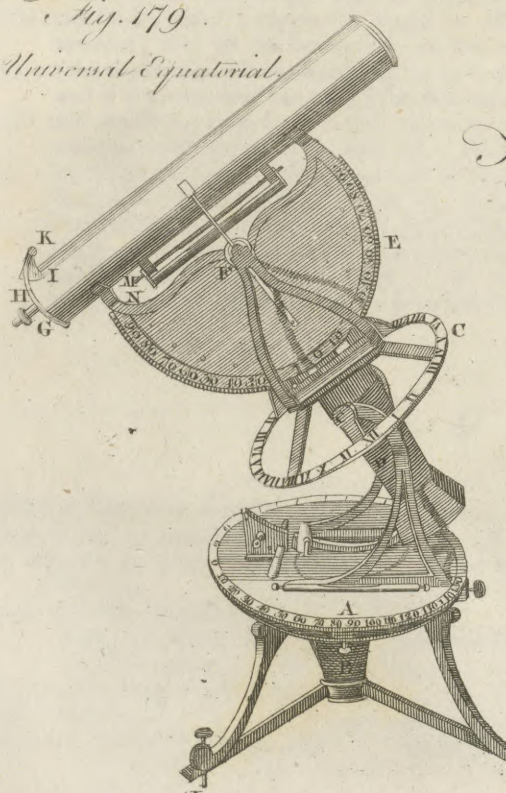


Fig. 177.

A. Bell Prin. Wal. Sculptor fecit.

Description of Astronomical Instruments.

tion of the telescope; and thus this axis will be at right angles to the polar axis. The next adjustment is to make the centre of cross hairs remain on the same object, while you turn the eye-tube quite round by the pinion of the refraction apparatus: for this adjustment, set the index on the slide to the first division on the dove-tail; and set the division marked 18″ on the refraction circle to its index; then look through the telescope, and with the pinion turn the eye-tube quite round; and if the centre of the hairs does not remain on the same spot during that revolution, it must be corrected by the four small screws, two and two at a time (which you will find upon unscrewing the nearest end of the eye-tube that contains the first eye-glass); repeat this correction till the centre of the hairs remains on the spot you are looking at during an entire revolution. In order to make the line of collimation parallel to the brass rod on which the level hangs, set the polar axis horizontal, and the declination-circle to 90°, adjust the level by the polar axis; look through the telescope on some distant horizontal object, covered by the centre of the cross hairs; then invert the telescope, which is done by turning the hour-circle half round; and if the centre of the cross hairs does not cover the same object as before, correct half the error by the uppermost and lowermost of the four small screws at the eye-end of the large tube of the telescope; this correction will give a second object now covered by the centre of the hairs, which must be adopted instead of the first object: then invert the telescope as before; and if the second object be not covered by the centre of the hairs, correct half the error by the same two screws which were used before: this correction will give a third object, now covered by the centre of the hairs, which must be adopted instead of the second object; repeat this operation till no error remains; then set the hour-circle exactly to 12 hours (the declination-circle remaining at 90° as before); and if the centre of the cross hairs does not cover the last object fixed on, set it to that object by the two remaining small screws at the eye-end of the large tube, and then the line of collimation will be parallel to the brass rod. For rectifying the nonius of the declination and equatorial circles, lower the telescope as many degrees, minutes, and seconds, below 0° or Æ on the declination-semicircle as are equal to the complement of the latitude; then elevate the polar axis till the bubble be horizontal, and thus the equatorial circle will be elevated to the colatitude of the place; set this circle to 6 hours; adjust the level by the pinion of the declination-circle; then turn the equatorial circle exactly 12 hours from the last position; and if the level be not right, correct one-half of the error by the equatorial circle, and the other half by the declination-circle; then turn the equatorial circle back again exactly 12 hours from the last position; and if the level be still wrong, repeat the correction as before till it be right, when turned to either position; that being done, set the nonius of the equatorial circle exactly to 6 hours, and the nonius of the declination-circle exactly to 0°.

The principal uses of this equatorial are,

1. To find your meridian by one observation only: for this purpose, elevate the equatorial circle to the colatitude of the place, and set the declination-semicircle to the sun's declination for the day and hour of the day required; then move the azimuth and hour circles both at the same time, either in the same or contrary direction, till you bring the centre of the cross hairs in the telescope exactly to cover the centre of the sun; when that is done, the index of the hour-circle will give the apparent or solar time at the instant of observation; and thus the time is gained, though the sun be at a distance from the meridian; then turn the hour-circle till the index points precisely at 12 o'clock, and lower the telescope to the horizon, in order to observe some point there in the centre of your glass, and that point is your meridian mark found by one observation only; the best time for this operation is three hours before or three hours after 12 at noon.

2. To point the telescope on a star, though not on the meridian, in full daylight. Having elevated the equatorial circle to the co-latitude of the place, and set the declination-semicircle to the star's declination, move the index of the hour-circle till it shall point to the precise time at which the star is then distant from the meridian, found in tables of the right ascension of the stars, and the star will then appear in the glass. Besides these uses peculiar to this instrument, it is also applicable to all the purposes to which the principal astronomical instruments, viz. a transit, a quadrant, and an equal altitude instrument, are applied.

INDEX.

Greenwich

Astrope-Wells || Astruc.

ASTROPE-WELLS, near Banbury in Oxfordshire, are recommended as excellent in many disorders. The water is a brisk, spirituous, pleasant-tasted chalybeate, and is also gently purgative. It should be drank from three to five quarts in the forenoon.

ASTROSCOPE, a kind of astronomical instrument, composed of two cones, on whose surface the constellations, with their stars, are delineated, by means whereof the stars may be easily known. The astroscope is the invention of William Schuckhard, formerly professor of mathematics at Tubingen, who published a treatise expressly on it in 1698.

ASTRUC, JOHN, a celebrated physician, was born in the year 1684, at the little town of Savoy, in the province of Languedoc. His father, who was a Protestant clergyman, bestowed particular pains upon the earliest part of his education. After which he went to the university of Montpelier, where he was created master of arts in the year 1700. He then began the study of medicine; and, in two years, obtained the degree of bachelor, having upon that occasion written a dissertation on the cause of fermentation, which he defended in a very spirited manner. On the 25th of January 1703 he was created doctor of physic; after which, before arriving at extensive practice he applied to the study of medical authors, both ancient and modern, with uncommon assiduity. The good effects of this study soon appeared; for, in the year 1710, he published a treatise concerning muscular motion, from which he acquired very high reputation. In the year 1717, he was appointed to teach medicine at Montpelier; which he did with such perspicuity and elo-

Astruc.

quence,

quence, that it was univerfally faid he had been born to be a profeffor. His fame foon rofe to fuch a height, that the king affigned him an annual falary; and he was, at the fame time, appointed to fuperintend the mineral-waters in the province of Languedoc. But as Montpelier did not afford fufficient fcope for his afpiring genius, he went to Paris with a great ftock of manufcripts, which he intended to publifh, after fubjecting them to the examination of the learned. Soon after, however, he left it, having in the year 1729 accepted the office of firft phyfician to the king of Poland. In this capacity he remained only for a fhort time, and he again returned to Paris. Upon the death of the celebrated Geoffroy, in the year 1731, he was appointed regius profeffor of medicine at Paris. The duties of this office he difcharged in fuch a manner as to anfwer even the moft fanguine expectations. He taught the practice of phyfic with fo great applaufe, as to draw from other univerfities to that of Paris a great concourfe of medical ftudents, foreigners as well as natives of France. At the fame time he was not more celebrated as a profeffor than a practitioner. And, even at an advanced age, he perfevered with unwearied affiduity in that intenfe ftudy which firft raifed his reputation. Hence it is that he has been enabled to tranfmit to pofterity fo many valuable monuments of his medical erudition. He died, univerfally regretted, on the 15th of May 1766, in the 82d year of his age.

ASTURIA, an ancient kingdom of Spain, fubdued by Auguftus emperor of Rome.—The inhabitants of this country, along with thofe of Cantabria, afferted their liberty long after the reft of Spain had received the Roman yoke. So great was their defire of liberty, that, after being clofely fhut up by the Roman army, they endured the moft terrible calamities of famine, even to the devouring of one another, rather than fubmit to the enemy. At length, however, the Afturians were for furrendering: but the Cantabrians oppofed this meafure, maintaining that they ought all to die fword in hand like brave men. Upon this the two nations quarrelled, notwithftanding their defperate fituation; and a battle enfuing, 10,000 of the Afturians were driven to the intrenchments of the Romans, whom they begged in the moft moving manner to receive them on any terms they pleafed. But Tiberius the emperor's fon-in-law refufing to admit them into the camp, fome of thefe unhappy people put an end to their lives by falling upon their own fwords; others lighting great fires threw themfelves into them, while fome poifoned themfelves by drinking the juice of a venomous herb.

The campaign being put an end to by winter, the next year the Afturians fummoned all their ftrength and refolution againft the Romans; but notwithftanding their utmoft efforts of valour and defpair, they were entirely defeated in a moft bloody battle, which lafted two days, and for that time entirely fubdued. A few years afterwards they rebelled, in conjunction with the Cantabrians; but were foon reduced by the Romans, who maffacred moft of the young men that were capable of bearing arms. This did not prevent them from revolting anew in a fhort time afterwards; but without fuccefs, being obliged to fubmit to the Roman power, till the fubverfion of that empire by the Goths.

Asturias, anciently the kingdom of Afturia, is now a principality of modern Spain, bounded by Bifcay on the eaft, Galicia on the weft, Old Caftile and Leon on the fouth, and the fea on the north. Its greateft length is about 110 miles, and its breadth 54. On the fouth it is feparated from Old Caftile and Leon by high mountains covered with woods. The province is tolerably fertile, but thinly inhabited. The inhabitants value themfelves much on being defcended from the ancient Goths. Even the poor peafants, who are fain to go to feek work in other provinces, call themfelves *illuftrious Goths* and *Mountaineers*, thinking it ignominious to marry even with great and rich families of another race. This pride is flattered by the refpect paid them by the reft of the nation, and the privileges beftowed upon them by the government. The hereditary prince of Spain is ftyled *prince of the Afturias*. The moft remarkable places in this principality are Oviedo, Gyon, Santillana, and St Andero.

ASTYAGES, fon of Cyaxares, the laft king of the Medes. He dreamed that from the womb of his daughter Mandane, married to Cambyfes king of Perfia, there fprung a vine that fpread itfelf over all Afia. She being with child, he refolved to kill the infant as foon as born. Its name was Cyrus; and Harpagus, being fent to deftroy it, preferved it: which Aftyages after a long time hearing of, he caufed Harpagus to eat his own fon. Harpagus called in Cyrus, who dethroned his grandfather, and thereby ended the monarchy of the Medes. See Media and Persia.

ASTYANAX, the only fon of Hector and Andromache. After the taking of Troy, he was thrown from the top of a tower by Ulyffes's orders.

ASTYNOMI, in *Grecian Antiquity*, magiftrates in Athens, correfponding to the ædiles of the Romans; they were ten in number. See Ædile.

ASYLUM, a fanctuary, or place of refuge, where criminals fhelter themfelves from the hands of juftice. The word is compounded of the primitive particle α, and συλαω, *I hurt;* becaufe no perfon could be taken out of an afylum without facrilege.

The afyla of altars and temples were very ancient; and likewife thofe of tombs, ftatues, and other monuments of confiderable perfonages. Thus, the temple of Diana at Ephefus was a refuge for debtors, the tomb of Thefeus for flaves. Among the Romans, a celebrated afylum was opened by Romulus between the mounts Palatine and Capitoline, in order to people Rome, for all forts of perfons indifcriminately, fugitive flaves, debtors, and criminals of every kind. The Jews had their afyla; the moft remarkable of which were, the fix cities of refuge, the temple, and the altar of burnt-offerings.

It was cuftomary among the Heathens to allow refuge and impunity even to the vileft and moft flagrant offenders; fome out of fuperftition, and others for the fake of peopling their cities: and it was by this means, and with fuch inhabitants, that Thebes, Athens, and Rome, were firft ftocked. We even read of afylums at Lyons and Vienne among the ancient Gauls; and there are fome cities in Germany which ftill preferve the

the ancient right of afylum. Hence on the medals of feveral ancient cities, particularly in Syria, we meet with the infcription ΑΣΥΛΟΙ, to which is added ΕΡΑΙ. This quality of afylum was given them, according to M. Spanheim, in regard to their temples, and to the gods revered by them.

The emperors Honorius and Theodofius granting the like immunities to churches, the bifhops and monks laid hold of a certain tract or territory, without which they fixed the bounds of the fecular jurifdiction: and fo well did they manage their privileges, that convents in a little time became next akin to fortreffes; where the moft notorious villains were in fafety, and braved the power of the magiftrate.

Thefe privileges at length were extended not only to the churches and churchyards, but alfo to the bifhops houfes; whence the criminal could not be removed without a legal affurance of life, and an entire remiffion of the crime. The reafon of the extenfion was, that they might not be obliged to live altogether in the churches, &c. where feveral of the occafions of life could not be decently performed.

But at length thefe afyla or fanctuaries were alfo ftripped of moft of their immunities, becaufe they ferved to make guilt and libertinage more bold and daring. In England, particularly, they were entirely abolifhed. See SANCTUARY.

ASYMMETRY, the want of proportion between the parts of any thing; being the contrary of *fymmetry*. Or, it is the relation of two quantities which have no common meafure, as between 1 and $\surd 2$, or the fide and diagonal of a fquare.

ASYMPTOTE, in *Geometry*, a line which continually approaches nearer to another; but, though continued infinitely, will never meet with it: Of thefe are many kinds. In ftrictnefs, however, the term *afymptotes* is appropriated to right lines, which approach nearer and nearer to fome curves of which they are faid to be *afymptotes;* but if they and their curves are indefinitely continued, they will never meet. See *CONIC Sections*.

ASYNDETON, in *Grammar*, a figure which omits the conjunctions in a fentence. As in *veni, vidi, vici*, where ET is left out; or in that of Cicero concerning Catiline, *abiit, exceffit, evafit, erupit:* or in that verfe of Virgil,

Ferte citò flammas, date vela, impellite remos.

Afyndeton ftands oppofed to polyfyndeton, where the copulatives are multiplied.

ATABULUS, in *Phyfiology*, a provincial wind in Apulia, of a dry pinching quality, and very noxious in its effects. The ancient naturalifts fpeak of the Atabulus in terms of horror, on account of the ravage it made among the fruits of the earth, which it fcorched or withered up.

ATABYRIS, a very high mountain in the ifland of Rhodes, on which, according to Strabo and Diodorus Siculus, there ftood a temple of Jupiter Atabyrius, whofe worfhip a colony of Rhodians carried into Sicily, where a temple was built to the fame deity at Agrigentum.

ATALANTA, an ifland in the Euripus of Eubœa, near the Locri Opuntii, faid to have been originally a city of the Locri, but torn from the continent in the time of the earthquake, and during an eruption of Mount Ætna. This happened in the fourth year of the 93d Olympiad, in the reign of Artaxerxes Mnemon.

ATALANTIS, ATLANTICA, or ATLANTIS. See ATLANTIS.

ATARAXY, a term ufed by the ftoics and fceptics, to denote that calmnefs of mind which fecures us from all emotions arifing from vanity and felf-conceit.

ATARGATIS FANUM, the temple of a goddefs worfhipped by the Syrians and Parthians, having the face of a woman and tail of a fifh, and called *Derceto* by the Greeks. Her temple ftood in the city Bambyce, called afterwards *Hieropolis*. It was extremely rich, infomuch that Craffus, in his march againft the Parthians, fpent feveral days in weighing the treafure. Voffius makes the name of this goddefs Phœnician from *Addir dag*, "the great fifh."

ATARNEA, an ancient town of Myfia, fituated between Adrymyttium and Pitane, remarkable for the marriage of Ariftotle with the fifter or concubine of the tyrant Hermias; alfo for the dotage of that philofopher.

ATAXY, in a general fenfe, the want of order: With phyficians, it fignifies irregularity of crifes and paroxyfms of fevers.

ATCHE, in *Commerce*, a fmall filver coin ufed in Turkey, and worth only one-third of the Englifh penny.

ATCHIEVEMENT, in *Heraldry*, denotes the arms of a perfon or family, together with all the exterior ornaments of the fhield; as helmet, mantle, creft, fcrolls, and motto, together with fuch quarterings as may have been acquired by alliances, all marfhalled in order.

ATCHIEVE. This term is derived from the French *achever*, i. e. to finifh or make an end of; but fignifies, in its ordinary acceptation, to perform great actions or exploits.

ATE, the goddefs of mifchief, in the Pagan theology. She was daughter of Jupiter, and caft down from heaven at the birth of Hercules. For Juno having deceived Jupiter, in caufing Euriftheus to be born before Hercules, Jupiter expreffed his refentment on Ate, as the author of that mifchief: and threw her headlong from heaven to the earth, fwearing fhe fhould never return thither again (*Homeri Il.* xix. 125.) The name of this goddefs comes from *ατaω, noceo*, "to hurt." Her being the daughter of Jupiter, means, according to mythologifts, that no evil happens to us but by the permiffion of Providence; and her banifhment to earth denotes the terrible effects of divine juftice among men.

ATEGUA, or ATTEUGA, an ancient town of Spain, placed by fome in the road from Antiquara, now Antequera, to Hifpalis, or Seville; by others near Alcala Real; which laft is the more probable fituation, becaufe the Flumen Salfum, now the Salado, was in its neighbourhood. Now *Tebala Vieja*, or *Teivela*.

ATELLA, an ancient town of Campania in Italy, between Capua and Neapolis. From this town the *Atellanæ fabulæ*, or *Atellani ludi*, took their name. Thefe were alfo called *Ofci*, from their inventor, in whofe territory Atella lay. They were generally a fpecies of farce, interlarded with much ribaldry and buffoonery; and fometimes were exordia or interludes prefented

between

between the acts of other plays. The actors in these farces were not reckoned among the common players, nor deemed infamous; but retained the rights of their tribe, and might be listed for soldiers, the privilege only of free men. The ruins of this town are still to be seen about 11 miles from the modern Aversa, which was built out of its materials.

ATEMPO GIUSTO, in *Music*, signifies to sing or play in an equal, true, and just time.

ATERGATIS, in *Mythology*, a goddess of the Syrians, supposed to be the mother of Semiramis. She was represented with the face and breasts of a woman, but the rest of her body resembled a fish. Vossius says the term signifies *without fish*, and conjectures that the votaries of this deity abstained from fish.

ATERNUM, a town of Lucania in Italy, now *Aterni*, (Cluverus): Also a town in the territory of the Piceni, now *Pescara*, a port-town of Naples, situated on the Adriatic. E. Long. 15. 25. N. Lat. 42. 30.

ATESTE, a town in the territory of Venice in Italy, now called *Este*. E. Long. 12. 6. N. Lat. 45. 25.

ATHAMADULET, the prime minister of the Persian empire, as the grand vizier is of the Turkish empire. He is great chancellor of the kingdom, president of the council, superintendant of the finances, and is charged with all foreign affairs.

ATHAMANTA, SPIGNEL. See BOTANY *Index*.

ATHANASIA, GOLDILOCKS. See BOTANY *Index*.

ATHANASIAN CREED; a formulary, or confession of faith, long supposed to have been drawn up by Athanasius bishop of Alexandria, in the fourth century, to justify himself against the calumnies of his Arian enemies. But it is now generally allowed among the learned not to have been his. Dr Waterland ascribes it to Hilary bishop of Arles, for the following among other reasons: 1. Because Honoratus of Marseilles, the writer of his life, tells us, that he composed an *Exposition of the Creed;* a properer title for the *Athanasian* than that of *Creed* simply which it now bears. 2. Hilary was a great admirer and follower of St Austin,; and the whole composition of this creed is in a manner upon St Austin's plan, both with respect to the Trinity and incarnation. 3. It is agreeable to the style of Hilary, as far as we can judge from the little that is left of his works. Upon the whole, he concludes, that Hilary bishop of Arles, about the year 430, composed *the Exposition of Faith*, which now bears the name of the *Athanasian Creed*, for the use of the Gallican clergy, and particularly those of the diocese of Arles: That, about the year 570, it became famous enough to be commented upon; but that all this while, and for several years lower, it had not yet acquired the name of *Athanasian*, but was simply styled *The Catholic Faith*: That, before 670, Athanasius's admired name came in to recommend and adorn it, being in itself an excellent system of the Athanasian principles of the Trinity and incarnation, in opposition chiefly to the Arians, Macedonians, and Apollinarians. This is the hypothesis of the learned author of the *Critical History of the Athanasian Creed*.

As to the reception of this creed in the Christian churches, we find, that it obtained in France in the time of Hincmar, or about 850: that it was received in Spain about 100 years later than in France, and in Germany much about the same time. As to our own country, we have clear and positive proofs of this creed being sung alternately in our churches in the tenth century. It was in common use in some parts of Italy, particularly in the diocese of Verona, about the year 960, and was received at Rome about the year 1014. As to the Greek and oriental churches, it has been questioned whether any of them ever received this creed at all; though some very considerable writers are of a contrary persuasion. It appears then, that the reception of this ereed has been both general and ancient; and may vie with any, in that respect, except the Nicene, or Constantinopolitan, the only general creed common to all the churches.

As to the matter of this creed, it is given as a summary of the true orthodox faith, and a condemnation of all heresies ancient and modern. Unhappily, however, it has proved a fruitful source of unprofitable controversy and unchristian animosity even down to the present time.

ATHANASIUS, ST, bishop of Alexandria, and one of the greatest defenders of the faith against the Arians, was born in Egypt. He followed St Alexander to the council of Nice, in 325, where he disputed against Arius, and the following years was made bishop of Alexandria; but, in 335, was deposed by the council of Tyre: when, having recourse to the emperor Constantine, the Arian deputies accused him of having hindered the exportation of corn from Alexandria to Constantinople; on which the emperor, without suffering him to make his defence, banished him to Treves. The emperor, two years, after, gave orders that he should be restored to his bishopric: but, on his return to Alexandria, his enemies brought fresh accusations against him, and chose Gregory of Cappadocia to his see; which obliged Athanasius to go to Rome to reclaim it of Pope Julius. He was there declared innocent, in a council held in 342, and in that of Sardica in 347; and two years after was restored to his see by order of the emperor Constans: but after the death of that prince, he was again banished by the emperor Constantius, which obliged him to retire into the deserts. The Arians then elected one George in his room; who being killed in a popular sedition under Julian in 360, St Athanasius returned to Alexandria, but was again banished under Julian, and restored to his see under Jovian. He addressed to that emperor a letter, in which he proposed that the Nicene creed should be the standard of the orthodox faith, and condemned those who denied the divinity of the Holy Ghost. He was also banished by Valens in 367, and afterwards recalled. St Athanasius died on the 2d of May 1703.

His works principally contain a defence of the mysteries of the Trinity, and of the incarnation and divinity of the Word and Holy Spirit. There are three editions of his works which are esteemed; that of Commelin, printed in 1600; that of Peter Nannius, in 1627; and that of Father Montfaucon. As to the creed which bears his name, see the preceding article.

ATHANATI, in Persian antiquity, a body of cavalry, consisting of 10,000 men, always complete. They were called *athanati* (a word originally Greek, and signifying *immortal*, because, when one of them happened to die, another was immediately appointed to succeed him.

ATHANOR. Chemists have distinguished by this name a furnace so constructed that it can always maintain an equal heat, and which shall last a long time without addition of fresh fuel.

The body of the athanor has nothing in it particular, and is constructed like ordinary furnaces. But at one of its sides, or its middle, there is an upright hollow tower, which communicates with the fireplace by one or more sloping openings, and which has a lid to close its upper opening. This furnace is now rarely used.

ATHAROTH, or ATROTH, in *Ancient Geography*, the name of several towns. Two appear to have been in Samaria, in the tribe of Ephraim; and one four miles to the north of Sebaste, or the city of Samaria; the other in the confines of Benjamin and Ephraim, yet so as to be in the district of Ephraim rather than Benjamin (Joshua). This the *Atroth-Adder* mentioned by Joshua xvi. 5. from which to Upper Bethoron extends the greatest breadth of the tribe of Ephraim.

ATHEISM, the disbelief of a deity. See ATHEIST.

ATHEIST, a person who does not believe the existence of a Deity. Many people, both ancient and modern, have pretended to atheism, or have been reckoned atheists by the world; but it is justly questioned whether any man seriously adopted such a principle. These pretensions, therefore, must be founded on pride or affectation.

Atheism, as absurd and unreasonable as it is, has had its martyrs. Lucilio Vanini, an Italian, native of Naples, publicly taught atheism in France, about the beginning of the 17th century; and, being convicted of it at Thoulouse, was condemned to death. Being pressed to make public acknowledgment of his crime, and to ask pardon of God, the king, and justice, he answered, he did not believe there was a God; that he never offended the king; and, as for justice, he wished it to the devil. He confessed that he was one of twelve, who parted in company from Naples to spread their doctrine in all parts of Europe. His tongue was first cut out, and then his body burnt, April 9. 1619.

Cicero represents it as a probable opinion, that they who apply themselves to the study of philosophy believe there are no gods. This must, doubtless, be meant of the academic philosophy, to which Cicero himself was attached, and which doubted of every thing. On the contrary, the Newtonian philosophers are continually recurring to a Deity, whom they always find at the end of their chain of natural causes. Some foreigners have even charged them with making too much use of the notion of a God in philosophy, contrary to the rule of Horace:

Nec Deus intersit, nisi dignus vindice nodus.

Among us, the philosophers have been the principal advocates for the existence of a Deity. Witness the writings of Sir Isaac Newton, Boyle, Ray, Cheyne, Nieuwentyt, &c. To which may be added many others, who, though of the clergy (as was also Ray), yet have distinguished themselves by their philosophical pieces in behalf of the existence of a God; *e. gr.* Derham, Bentley, Whiston, Samuel and John Clarke, Fenelon, &c. So true is that saying of Lord Bacon, that though a smattering of philosophy may lead a man into atheism, a deep draught will certainly bring him back again to the belief of a God and Providence.

ATHELING, ADELING, EDLING, ETHLING, or ETHELING, among the Anglo-Saxons, was a title of honour, properly belonging to the heir-apparent, or presumptive, to the crown. This honourable appellation was first conferred by King Edward the Confessor on Edgar, to whom he was great uncle, when, being without any issue of his own, he intended to make him his heir.

ATHELSTAN, a Saxon king of England, natural son of Edward the elder, and grandson of the great Alfred. He succeeded to the crown in 925, and reigned 16 years. There was a remarkable law passed by this prince, which shows his just sentiments of the advantages of commerce, as well as the early attention to it in this country: it declared, that any merchant who made three voyages on his own account beyond the British channel or narrow seas, should be entitled to the privilege of a thane or gentleman.

ATHENÆA, in *Antiquity*, a feast celebrated by the ancient Greeks in honour of Minerva, who was called *Athene*.

ATHENÆUM, in *Antiquity*, a public place wherein the professors of the liberal arts held their assemblies, the rhetoricians declaimed, and the poets rehearsed their performances. These places, of which there were a great number at Athens, were built in the manner of amphitheatres, encompassed with seats, called *cunei*. The three most celebrated Athenæa were those at Athens, at Rome, and at Lyons, the second of which was built by the emperor Adrian.

ATHENÆUS, a physician, born in Cilicia, cotemporary with Pliny, and founder of the pneumatic sect. He taught that the fire, air, water, and earth, are not the true elements, but that their qualities are, viz. heat, cold, moisture, and dryness; and to these he added a fifth element, which he called *spirit*, whence his sect had its name.

ATHENÆUS, a Greek grammarian, born at Naucratis in Egypt in the 3d century, one of the most learned men of his time. Of all his works we have none extant but his Deipnosophi, i. e. the sophists at table. There is an infinity of facts and quotations in this work which render it very agreeable to admirers of antiquity.

There was also a mathematician of this name, who wrote a treatise on mechanics, which is inserted in the works of the ancient mathematicians, printed at Paris in 1693, in folio, in Greek and Latin.

ATHENAGORAS, an Athenian philosopher, flourished about the middle of the 2d century, and was remarkable for his zeal for Christianity, and his great learning, as appears from the apology which he addressed to the emperors Marcus Aurelius Antoninus and Lucius Commodus.

Athenodorus || Athens.

ATHENODORUS, a famous ſtoic philoſopher, born at Tarſus, went to the court of Auguſtus, and was made by him tutor to Tiberius. Auguſtus had a great eſteem for him, and found him by experience a man of virtue and probity. He uſed to ſpeak very freely to the emperor. He, before he left the court to return home, warned the emperor not to give himſelf up to anger, but, whenever he ſhould be in a paſſion, to rehearſe the 24 letters of the alphabet before he reſolved to ſay or do any thing. He did not live to ſee his bad ſucceſs in the education of Tiberius.

ATHENOPOLIS, a town of the Maſſilienſes, an ancient nation of Gaul. It is conjectured by Harduin to be the ſame with *Telo Martias*, now *Toulon*; by others to be the ſame with *Antipolis* or *Antibes*.

ATHENREE, a town of Ireland in the county of Galway, and province of Connaught. W. Long. 8. 5. N. Lat. 53. 14. It is governed by a portrieve, and hath a barrack for three companies of foot. It hath been a place of conſiderable ſtrength; but, like the numerous churches and caſtles which ſurround it, has felt the reſiſtleſs force of time. Some of the walls and towers, however, are ſtill remaining, as monuments of its former grandeur.

ATHENS, a celebrated city of Greece, and capital of the ancient kingdom of Attica, ſituated in E. Long. 24. N. Lat. 38. 5. See ATTICA.

1 By whom founded.

In early times, that which was afterwards called the *citadel* was the whole city; and went under the name of *Cecropia*, from its founder Cecrops, whom the Athenians in after times affirmed to have been the firſt builder of cities, and called this therefore by way of eminence *Polis*, i. e. the city. In the reign of Erichthonius it loſt the name of *Cecropia*, and acquired that of *Athens*, on what account is not certain; the moſt probable is, that it was ſo named in reſpect to the goddeſs Minerva, whom the Greeks call *Athene*, who was alſo eſteemed its protectreſs. This old city was ſeated on the top of a rock in the midſt of a large and pleaſant plain, which, as the number of inhabitants increaſed, became full of buildings, which induced the diſtinction of Acro and Catapolis, i. e. of the upper and lower city. The extent of the citadel was 60 ſtadia; it was ſurrounded by olive trees, and fortified, as ſome ſay, with a ſtrong palliſade; in ſucceeding times it was encompaſſed with a ſtrong wall, in which there were nine gates, one very large one, and the reſt ſmall. The inſide of the citadel was adorned with innumerable edifices. The moſt remarkable of which were, 1. The magnificent temple of Minerva, ſtyled *parthenion*, becauſe that goddeſs was a virgin. The Perſians deſtroyed it; but it was rebuilt with ſtill greater ſplendour by the famous Pericles, all of the fineſt marble, with ſuch ſkill and ſtrength, that, in ſpite of the rage of time and barbarous nations, it remains perhaps the firſt antiquity in the world, and ſtands a witneſs to the truth of what ancient writers have recorded of the prodigious magnificence of Athens in her flouriſhing ſtate. 2. The temple of Neptune and of Minerva; for it was divided into two parts: one ſacred to the god, in which was the ſalt fountain ſaid to have ſprung upon the ſtroke of his trident; the other to the goddeſs protectreſs of Athens, wherein was the ſacred olive which ſhe produced, and her image which fell down from heaven in the reign of Erichthonius. At the back of Minerva's temple was the public treaſury, which was burnt to the ground through the knavery of the treaſurers, who, having miſapplied the revenues of the ſtate, took this ſhort method of making up accounts.

2 Remarkable buildings.

The lower city comprehended all the buildings ſurrounding the citadel, the fort Munychia, and the havens Phalcrum and Piræus, the latter of which was joined to the city by walls five miles in length; that on the north was built by Pericles, but that on the ſouth by Themiſtocles; but by degrees the turrets which were at firſt erected on thoſe walls were turned into dwelling-houſes for the accommodation of the Athenians, whoſe large city was now become too ſmall for them. The city, or rather the lower city, had 13 great gates, with the names of which it is not neceſſary to trouble the reader. Among the principal edifices which adorned it, we may reckon, 1. The temple of Theſeus, erected by Conon, near its centre. Adjacent thereto, the young people performed their exerciſes. It was alſo a ſanctuary for diſtreſſed perſons, ſlaves or free. 2. The Olympian temple erected in honour of Jupiter, the honour of Athens, and of all Greece. The foundation of it was laid by Piſiſtratus: it was carried on but ſlowly in ſucceeding times, 700 years elapſing before it was finiſhed, which happened under the reign of Adrian, who was particularly kind to Athens: this was the firſt building in which the Athenians beheld pillars. 3. The pantheon, dedicated to all the gods; a moſt noble ſtructure, ſupported by 120 marble pillars, and having over its great gate two horſes carved by Praxiteles: it is yet remaining, as we ſhall have occaſion to ſhow hereafter when we come to ſpeak of the preſent ſtate of this famous city. In ſeveral parts of it were *ſtaoi* or porticoes, wherein people walked in rainy weather, and from whence a ſect of philoſophers were denominated *ſtoics*, becauſe their maſter Zeno taught in thoſe porticoes.

3 Ceramicus.

There were at Athens two places called *Ceramicus*, from Ceramus the ſon of Bacchus and Ariadne; one within the city, containing a multitude of buildings of all ſorts; the other in the ſuburbs, in which was the academy and other edifices. The gymnaſia of Athens were many; but the moſt remarkable were the Lyceum, Academia, and Cynoſarges. The Lyceum ſtood on the banks of the Iliſſus; ſome ſay it was built by Piſiſtratus, others by Pericles, others by Lycurgus. Here Ariſtotle taught philoſophy, inſtructing ſuch as came to hear him as they walked, whence his diſciples are generally thought to derive the name of *peripatetics*. The ceramicus without the city was the diſtance of ſix ſtadia from its walls. The academy made part thereof; as to the name of which there is ſome diſpute. Some affirm that it was ſo called from Academus, an ancient hero, who, when Helen was ſtolen by Theſeus, diſcovered the place where ſhe lay hid to Caſtor and Pollux: for which reaſon the Lacedemonians, when they invaded Attica, always ſpared this place. Dicæarchus writes, that Caſtor and Pollux had two Arcadians in their army, the one named *Echedemus*, the other *Marothus*; from the former of theſe he ſays this place took its name, and that the borough of Marathon was ſo called from the other. It was a marſhy unwholeſome place, till Cimon was at great pains to have it drained; and then it became extremely pleaſant

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ſant and delightful, being adorned with ſhady walks, where Plato read his lectures, and from thence his ſcholars were ſtyled *academics*. The Cynoſarges was a place in the ſuburbs not far from the Lyceum: it was famous on many accounts; but particularly for a noble gymnaſium erected there, appointed for the ſpecial uſe of ſuch as were Athenians only by one ſide. In after times Themiſtocles derived to himſelf ill will, by carrying many of the nobility to exerciſe with him here, becauſe, being but of the half blood, he could exerciſe nowhere elſe but in this gymnaſium. Antiſthenes inſtituted a ſect of philoſophers, who from the name of this diſtrict, as many think, were ſtyled *Cynics*.

4 Cynoſarges.

5 Havens.

The havens of Athens were three. Firſt the Piræus, which was diſtant about 35 or 40 ſtadia from the city, till joined thereto by the long walls beforementioned, after which it became the principal harbour of the city. It had three docks; Cantharos, Aphrodiſium, and Zea; the firſt was ſo called from an ancient hero, the ſecond from the goddeſs Venus who had there two temples, and the third from bread-corn. There were in this port five porticoes, which joining together formed one great one called from thence *Macra Stoa*, or the grand portico. There were likewiſe two great markets or fora: one near the long portico, the other near the city. The ſecond port was Munichia, a promontory not far diſtant from Pyræus; a place very ſtrong by nature, and afterwards rendered far ſtronger by art. It was of this that Epimenides ſaid, if the Athenians foreſaw what miſchief it would one day produce to them, they would eat it away with their teeth. The third was Phalerum, diſtant from the city, according to Thucydides 35 ſtadia, but according to Pauſanias only 20. This was the moſt ancient harbour of Athens, as Pyræus was the moſt capacious.

6 Preſent ſtate.

Of this city, as it ſtands at preſent, we have the following account by Dr Chandler. "It is now called *Athini;* and is not inconſiderable, either in extent or the number of inhabitants. It enjoys a fine temperature, and a ſerene ſky. The air is clear and wholeſome, though not ſo delicately ſoft as in Ionia. The town ſtands beneath the acropolis or citadel; not encompaſſing the rock as formerly, but ſpreading into the plain, chiefly on the weſt and north-weſt. Corſairs infeſting it, the avenues were ſecured, and in 1676 the gates were regularly ſhut after ſunſet. It is now open again: but ſeveral of the gateways remain, and a guard of Turks patrols at midnight. Some maſſes of brick-work, ſtanding ſeparate, without the town, belonged perhaps to the ancient wall, of which other traces alſo appear. The houſes are moſtly mean and ſtraggling; many with large courts or areas before them. In the lanes, the high walls on each ſide, which are commonly white-waſhed, reflect ſtrongly the heat of the ſun. The ſtreets are very irregular; and anciently were neither uniform nor handſome. They have water conveyed in channels from Mount Hymettus, and in the bazar or market-place is a large fountain. The Turks have ſeveral moſques and public baths. The Greeks have convents for men and women; with many churches, in which ſervice is regularly performed; and beſides theſe, they have numerous oratories or chapels, ſome in ruins or conſiſting of bare walls, frequented only on the anniverſaries of the ſaints to whom they are dedicated. A portrait of the owner on a board is placed in them on that occaſion, and removed when the ſolemnity of the day is over.

7 Citadel, or city of Cecrops.

"The city of Cecrops is now a fortreſs with a thick irregular wall, ſtanding on the brink of precipices, and encloſing a large area about twice as long as broad. Some portions of the ancient wall may be diſcovered on the outſide, particularly at the two extreme angles; and in many places it is patched with pieces of columns, and with marbles taken from the ruins. A conſiderable ſum had been recently expended on the ſide next Hymettus, which was finiſhed before we arrived. The ſcaffolding had been removed to the end toward Pentele; but money was wanting, and the workmen were withdrawn. The garriſon conſiſts of a few Turks who reſide there with their families, and are called by the Greeks *Caſtriani*, or the ſoldiers of the caſtle. The rock is lofty, abrupt, and inacceſſible, except the front, which is toward the Piræus; and on that quarter is a mountainous ridge, within cannon-ſhot. It is deſtitute of water fit for drinking; and ſupplies are daily carried up in earthen jars, on horſes and aſſes, from one of the conduits of the town.

"The acropolis furniſhed a very ample field to the ancient virtuoſi. It was filled with monuments of Athenian glory, and exhibited an amazing diſplay of beauty, of opulence, and of art; each contending as it were for the ſuperiority. It appeared as one entire offering to the Deity, ſurpaſſing in excellence and aſtoniſhing in richneſs. Heliodorus, named Periegetes, *the guide*, had employed on it 15 books. The curioſities of various kinds, with the pictures, ſtatues, and pieces of ſculpture, were ſo many and ſo remarkable, as to ſupply Polemo Periegetes with matter for four volumes; and Strabo affirms, that as many would be required in treating of other portions of Athens and of Attica. In particular, the number of ſtatues was prodigious. Tiberius Nero, who was fond of images, plundered the acropolis as well as Delphi and Olympia; yet Athens, and each of theſe places, had not fewer than 3000 remaining in the time of Pliny. Even Pauſanias ſeems here to be diſtreſſed by the multiplicity of his ſubject. But this banquet, as it were, of the ſenſes has long been withdrawn; and is now become like the tale of a viſion. The ſpectator views with concern the marble ruins intermixed with mean flat-roofed cottages, and extant amid rubbiſh; the ſad memorials of a nobler people; which, however, as viſible from the ſea, ſhould have introduced modern Athens to more early notice. They who reported it was only a ſmall village, muſt, it has been ſurmiſed, have beheld the acropolis through the wrong end of their teleſcopes.

"The acropolis has now, as formerly, only one entrance, which fronts the Piræus. The aſcent is by traverſes and rude fortifications furniſhed with cannon, but without carriages, and neglected. By the ſecond gate is the ſtation of the guard, who ſits croſs-legged under cover, much at his eaſe, ſmoking his pipe, or drinking coffee, with his companions about him in like attitudes. Over this gateway is an inſcription in large characters on a ſtone turned upſide down, and black from the fires made below. It records a preſent of a pair of gates.

8 Propyléa.

"Going farther up, you come to the ruins of the propyléa, an edifice which graced the entrance into the

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citadel. This was one of the ftructures of Pericles, who began it when Euthymenes was archon, 435 years before Chrift. It was completed in five years, at the expence of 2012 talents. It was of marble, of the Doric order, and had five doors to afford an eafy paffage to the multitudes which reforted on bufinefs or devotion to the acropolis.

While this fabric was building, the architect Mnefícles, whofe activity equalled his fkill, was hurt by a fall, and the phyficians defpaired of his life: but Minerva, who was propitious to the undertaking, appeared, it was faid, to Pericles, and prefcribed a remedy, by which he was fpeedily and eafily cured. It was a plant or herb growing round about the acropolis, and called afterwards *parthenium*.

9 Temple of Victory.

"The right wing of the propyléa was a temple of Victory. They related that Ægeus had ftood there, viewing the fea, and anxious for the return of his fon Thefeus, who was gone to Crete with the tributary children to be delivered to the Minotaur. The veffel which carried them had black fails fuiting the occafion of its voyage; and it was agreed, that, if Thefeus overcame the enemy, their colour fhould be changed to white. The neglect of this fignal was fatal to Ægeus, who, on feeing the fails unaltered, threw himfelf down headlong from the rock, and perifhed. The idol was named *Victory without wings;* it was faid, becaufe the news of the fuccefs of Thefeus did not arrive but with the conqueror. It had a pomegranate in the right hand, and a helmet in the left. As the ftatue was without pinions, it was hoped the goddefs would remain for ever on the fpot.

"On the left wing of the propyléa, and fronting the temple of Victory, was a building decorated with paintings by Polygnotus, of which an account is given by Paufanias. This edifice, as well as the temple, was of the Doric order, the columns fluted, and without bafes. Both contributed alike to the uniformity and grandeur of the defign; and the whole fabric, when finifhed, was deemed equally magnificent and ornamental. The interval between Pericles and Paufanias confifts of feveral centuries. The propyléa remained entire in the time of this topographer; and, as will be fhown, continued nearly fo to a much later period. It had then a roof of white marble, which was unfurpaffed either in the fize of the ftones or in the beauty of their arrangement; and before each wing was an equeftrian ftatue.

"The propyléa have ceafed to be the entrance of the acropolis. The paffage which was between the columns in the centre, is walled up almoft to their capitals, and above is a battery of cannon. The way now winds before the front of the ancient ftructure; and turning to the left hand among rubbifh and mean walls, you come to the back part, and to the five door-ways. The foil without is rifen higher than the top of the two fmaller. There, under the vault and cannon, lies a heap of large ftones, the ruin of the roof.

"The temple of Victory, ftanding on an abrupt rock, has its back and one fide encumbered with the modern ramparts. The columns in the front being walled up, you enter it by a breach in the fide, within the propyléa. It was ufed by the Turks as a magazine for powder, until about the year 1656, when a fudden explofion, occafioned by lightning, carried away the roof, with a houfe erected on it, belonging to the officer who commanded in the acropolis, whofe family, except a girl, perifhed. The women of the aga continued to inhabit this quarter, but it is now abandoned and in ruins.

10 Roof carried off by an explofion.

"The cell of the temple of Victory, which is of white marble, very thick, and ftrongly cemented, fufficiently witneffes the great violence it has undergone; the ftones in many places being disjointed, as it were, and forced from their original pofition. Two of thefe making an acute angle, the exterior edges touching, without the crevice; and the light abroad being much ftronger than in the room, which has a modern roof and is dark; the portion in contact becoming pellucid, had illumined the vacant fpace with a dim colour refembling that of amber. We were defired to examine this extraordinary appearance, which the Greeks regarded as a ftanding miracle, and which the Turks, who could not confute them, beheld with equal aftonifhment. We found in the gape fome coals, which had been brought on a bit of earthen ware for the purpofe of burning incenfe, as we fuppofed, and alfo a piece of wax-taper, which probably had been lighted in honour of the faint and author of the wonder; but our Swifs unfortunately carrying his own candle too far in, the fmoke blackened the marble, and deftroyed the phenomenon.

"The building oppofite to the temple has ferved as a foundation for a fquare lofty tower of ordinary mafonry. The columns of the front are walled up, and the entrance is by a low iron gate in the fide. It is now ufed as a place of confinement for delinquents: but in 1676 was a powder-magazine. In the wall of a rampart near it are fome fragments of exquifite fculpture, reprefenting the Athenians fighting with the Amazons. Thefe belong to the frieze, which was then ftanding. In the fecond century, when Paufanias lived, much of the painting was impaired by age, but fome remained, and the fubjects were chiefly taken from the Trojan ftory. The traces are fince vanifhed.

"The pediment of the temple of Victory, with that of the oppofite wing, is defcribed as remaining in 1676; but on each building a fquare tower had been erected. One of the fteps in the front of the propyléa was entire, with the four columns, their entablature, and the pediment. The portico, to which the five doorways belonged, confifted of a large fquare room, roofed with flabs of marble, which were laid on two great marble beams, and fuftained by four beautiful columns. Thefe were Ionic, the proportions of this order beft fuiting that purpofe, as taller than the Doric; the reafon it was likewife preferred in the pronaos of the temple of Victory. The roof of the propyléa, after ftanding above 2000 years, was probably deftroyed, with all the pediments, by the Venetians in 1687, when they battered the caftle in front, firing red-hot bullets, and took it, but were compelled to refign it again to the Turks in the following year. The exterior walls, and, in particular, a fide of the temple of Victory, retain many marks of their hoftilities.

11 Temple of Minerva.

"The chief ornament of the acropolis was the parthenon or great temple of Minerva, a moft fuperb and magnificent fabric. The Perfians had burned the edifice which before occupied the fite, and was called *hecatompedon*, Athens. *hecatompedon*, from its being 100 feet ſquare. The zeal of Pericles and of all the Athenians was exerted in providing a far more ample and glorious reſidence for their favourite goddeſs. The architects were Callicrates and Ictinus; and a treatiſe on the building was written by the latter and Carpion. It was of white marble, of the Doric order, the columns fluted and without baſes, the number in front eight; and adorned with admirable ſculpture. The ſtory of the birth of Minerva was carved in the front pediment; and in the back, her conteſt with Neptune for the country. The beaſts of burden, which had conveyed up the materials, were regarded as ſacred, and recompenſed with paſtures; and one, which had voluntarily headed the train, was maintained during life, without labour, at the public expence.

12 Her ſtatue. "The ſtatue of Minerva, made for this temple by Phidias, was of ivory, 26 cubits or 39 feet high. It was decked with pure gold to the amount of 44 talents, ſo diſpoſed by the advice of Pericles as to be taken off and weighed if required. The goddeſs was repreſented ſtanding, with her veſtment reaching to her feet. Her helmet had a ſphinx for the creſt, and on the ſides were griffins. The head of Meduſa was on her breaſtplate. In one hand ſhe held her ſpear, and in the other ſupported an image of Victory about four cubits high. The battle of the Centaurs and Lapithæ was carved on her ſandals; and on her ſhield, which lay at her feet, the war of the gods and giants, and the battle of the Athenians and Amazons. By her ſpear was a ſerpent, in alluſion to the ſtory of Erichthonius; and on the pedeſtal, the birth of Pandora. The Sphinx, the Victory, and Serpent, were accounted eminently wonderful. This image was placed in the temple in the firſt year of the 87th Olympiad, in which the Peloponneſian war began. The gold was ſtripped off by the tyrant Lychares, when Demetrius Poliorcetes compelled him to fly. The ſame plunderer plucked down the golden ſhields in the acropolis, and carried away the golden Victories, with the precious veſſels and ornaments provided for the Panathenæan feſtival.

"The parthenon remained entire for many ages after it was deprived of the goddeſs. The Chriſtians converted it into a church, and the Mahometans into a moſque. It is mentioned in the letters of Cruſius, and miſcalled the *pantheon* and the *temple of the unknown God*. The Venetians under Koningſmark, when they beſieged the acropolis in 1687, threw a bomb, which demoliſhed the roof, and, ſetting fire to ſome powder, did much damage to the fabric. The floor, which is indented, ſtill witneſſes the place of its fall. This was the ſad forerunner of farther deſtruction; the Turks breaking the ſtones, and applying them to the building of a new moſque, which ſtands within the ruin, or to the repairing their houſes and the walls of the fortreſs. The vaſt pile of ponderous materials, which lay ready, is greatly diminiſhed; and the whole ſtructure will gradually be conſumed and diſappear.

13 Temple converted into a moſque. "The temple of Minerva in 1676 was, as Wheeler and Spon aſſert, the fineſt moſque in the world, without compariſon. The Greeks had adapted the fabric to their ceremonial, by conſtructing at one end a ſemicircular receſs for the holy tables, with a window; for before it was enlightened only by the door, obſcurity being preferred under the heathen ritual, except on feſtivals, when it yielded to ſplendid illuminations: the reaſon, it has been ſurmiſed, why temples are commonly found ſimple and unadorned on the inſides. In the wall beneath the window were inſerted two pieces of the ſtone called *phengites*, a ſpecies of marble diſcovered in Cappadocia in the time of Nero; and ſo tranſparent that he erected with it a temple to Fortune, which was luminous within when the door was ſhut. Theſe pieces were perforated, and the light which entered was tinged with a reddiſh or yellowiſh hue. The picture of the Panagia or Virgin Mary, in moſaic, on the ceiling of the receſs, remained; with two jaſper columns belonging to the ſcreen, which had ſeparated that part from the nave; and within, a canopy ſupported by four pillars of porphyry, with Corinthian capitals of white marble, under which the table had been placed; and behind it, beneath the window, a marble chair for the archbiſhop; and alſo a pulpit ſtanding on four ſmall pillars in the middle aile. The Turks had white-waſhed the walls, to obliterate the portraits of ſaints, and the other paintings, with which the Greeks decorate their places of worſhip; and had erected a pulpit on the right hand for their iman or reader. The roof was diſpoſed in ſquare compartments; the ſtones maſſive; and ſome had fallen in. It had been ſuſtained in the pronaos by ſix columns; but the place of one was then ſupplied by a large pile of rude maſonry, the Turks not having been able to fill up the gap more worthily. The roof of the naos was ſupported by colonnades ranging with the door, on each ſide; and conſiſting of 22 pillars below, and of 23 above. The odd one was over the entrance, which by that diſpoſition was left wide and unembarraſſed. In the portico were ſuſpended a few lamps, to be uſed in the moſque at the ſeaſons when the muſſelmans aſſemble before day-break, or to be lighted up round the minaret, as is the cuſtom during their Ramazan or Lent.

"It is not eaſy to conceive a more ſtriking object than the parthenion, though now a mere ruin. The columns within the naos have all been removed: but on the floor may be ſeen the circles which directed the workmen in placing them; and at the farther end is a groove acroſs it, as for one of the partitions of the cell. The receſs erected by the Chriſtians is demoliſhed; and from the rubbiſh of the ceiling the Turkiſh boys collect bits of the moſaic, of different colours, which compoſed the picture. We were told at Smyrna, that this ſubſtance had taken a poliſh, and been ſet in buckles. This cell is about half demoliſhed; and in the columns which ſurrounded it is a large gap near the middle. On the walls are ſome traces of the paintings. Before the portico is a reſervoir ſunk in the rock, to ſupply the Turks with water for the purifications cuſtomary on entering their moſques. In it, on the left hand, is the rubbiſh of the pile erected to ſupply the place of a column; and on the right, a ſtaircaſe, which leads out on the architrave, and has a marble or two with inſcriptions, but worn ſo as not to be legible. It belonged to the minaret, which has been deſtroyed. 14 Magnificent ruin.

"The travellers, to whom we are indebted for an account of the moſque, have likewiſe given a deſcription 15 Sculptures.

Athens. tion of the ſculpture then remaining in the front. In the middle of the pediment was ſeen a bearded Jupiter, with a majeſtic countenance, ſtanding, and naked; the right arm broken. The thunderbolt, it has been ſuppoſed, was placed in that hand, and the eagle between his feet. On his right was a figure, it is conjectured, of Victory, clothed to the mid-leg; the head and arms gone. This was leading on the horſes of a car, in which Minerva ſat, young and unarmed; her head-dreſs, inſtead of a helmet, reſembling that of a Venus. The generous ardour and lively ſpirit viſible in this pair of celeſtial ſteeds, was ſuch as beſpoke the hand of a maſter, bold and delicate, of a Phidias or Praxiteles. Behind Minerva was a female figure, without a head, ſitting with an infant in her lap; and in this angle of the pediment was the emperor Hadrian with his arm round Sabina, both reclining, and ſeeming to regard Minerva with pleaſure. On the left ſide of Jupiter were five or ſix other trunks to complete the aſſembly of deities, into which he received her. Theſe figures were all wonderfully carved, and appeared as big as life. Hadrian and his conſort, it is likely, were complimented by the Athenians with places among the marble gods in the pediment, as benefactors. Both of them may be conſidered as intruders on the original company; and poſſibly their heads were placed on trunks, which before had other owners. They ſtill poſſeſs their corner, and are eaſy to be recogniſed though not unimpaired. The reſt of the ſtatues are defaced, removed, or fallen. Moroſini was ambitious to enrich Venice with the ſpoils of Athens; and by an attempt to take down the principal group, haſtened their ruin. In the other pediment is a head or two of ſea-horſes finely executed, with ſome mutilated figures; and on the architrave beneath them are marks of the fixtures of votive offerings, perhaps of the golden ſhields, or of feſtoons ſuſpended on ſolemn occaſions, when the temple was dreſſed out to receive the votaries of the goddeſs.

16 Erectheum. “ Neptune and Minerva, once rival deities, were joint and amicable tenants of the Erectheum, in which was an altar of Oblivion. The building was double, a partition wall dividing it into two temples, which fronted different ways. One was the temple of Neptune Erectheus, the other of Minerva Polias. The latter was entered by a ſquare portico connected with a marble ſkreen, which fronts towards the propyléa. The door of the cell was on the left hand: and at the farther end of the paſſage was a door leading down into the Pandroſeum, which was contiguous.

17 Temple of Neptune Erectheus. “ Before the temple of Neptune Erectheus was an altar of Jupiter *the ſupreme*, on which no living thing was ſacrificed, but they offered cakes without wine. Within it was the altar of Neptune and Erectheus; and two, belonging to Vulcan and a hero named *Butes*, who had tranſmitted the prieſthood to his poſterity, which were called *Butadæ*. On the walls were paintings of this illuſtrious family, from which the prieſteſs of Minerva Polias was alſo taken. It was aſſerted that Neptune had ordained the well of ſalt water, and the figure of a trident in the rock, to be memorials of his contending for the country. The former, Pauſanias remarks, was no great wonder, for other wells of a ſimilar nature were found inland; but this when the ſouth wind blew, afforded the ſound of waves.

18 Of Minerva Polias. “ The temple of Minerva Polias was dedicated by all Attica, and poſſeſſed the moſt ancient ſtatue of the goddeſs. The demi or towns had other deities, but their zeal for her ſuffered no diminution. The image, which they placed in the acropolis, then the city, was in after ages not only reputed conſummately holy, but believed to have fallen down from heaven in the reign of Erichthonius. It was guarded by a large ſerpent, which was regularly ſerved with offerings of honeyed cakes for his food. This divine reptile was of great ſagacity, and attained to an extraordinary age. He wiſely withdrew from the temple when in danger from the Medes; and, it is ſaid, was living in the ſecond century. Before this ſtatue was an owl; and a golden lamp. This continued burning day and night. It was contrived by a curious artiſt, named *Callimachus*, and did not require to be repleniſhed with oil oftener than once a year. A brazen palm-tree, reaching to the roof, received its ſmoke. Ariſtion had let the holy flame expire while Sylla beſieged him, and was abhorred for his impiety. The original olive-tree, ſaid to have been produced by Minerva, was kept in this temple. When the Medes ſet fire to the acropolis, it was conſumed; but, they aſſerted, on the following day, was found to have ſhot up again as much as a cubit. It grew low and crooked, but was eſteemed very holy. The prieſteſs of Minerva was not allowed to eat of the new cheeſe of Attica; and, among her perquiſites, was a meaſure of wheat, and one of barley, for every birth and burial. This temple was again burned when Callias was archon, 24 years after the death of Pericles. Near it was the tomb of Cecrops, and within it Erectheus was buried.

“ The ruin of the Erectheum is of white marble; the architectural ornaments of very exquiſite workmanſhip, and uncommonly curious. The columns of the front of the temple of Neptune are ſtanding with the architrave; and alſo the ſkreen and portico of Minerva Polias, and with a portion of the cell retaining traces of the partition-wall. The order is Ionic. An edifice revered by ancient Attica, as holy in the higheſt degree, was in 1676 the dwelling of a Turkiſh family, and is now deſerted and neglected; but many ponderous ſtones and much rubbiſh muſt be removed before the well and trident would appear. The former, at leaſt, might probably be diſcovered. The portico is uſed as a powder-magazine; but we obtained permiſſion to dig and examine the outſide. The door-way of the veſtibule is walled up, and the ſoil riſen nearly to the top of the door-way of the prandoſeum. By the portico is a battery commanding the town, from which aſcends an amuſing hum. The Turks fire from it, to give notice of the commencement of Ramazan or of their Lent, and of Bairam or the holy-days, and on other public occaſions.

“ The prandoſeum is a ſmall, but very particular building, of which no ſatisfactory idea can be communicated by deſcription. The entablature is ſupported by women called *Caryatides*. Their ſtory is thus related. The Greeks, victorious in the Perſian war, jointly deſtroyed Carya, a city of the Peloponneſus, which had favoured the common enemy. They cut off

off the males, and carried into captivity the women, whom they compelled to retain their former dress and ornaments, though in a state of servitude. The architects of those times, to perpetuate the memory of their punishment, represented them, as in this instance, each with a burden on her head, one hand uplifted to it and the other hanging down by her side. The images were in number six, all looking toward the parthenon. The four in front, with that next to the propylea, remain, but mutilated, and their faces besmeared with paint. The soil is risen almost to the top of the basement on which they are placed. This temple was open or latticed between the statues; and in it also was a stunted olive-tree, with an altar of Jupiter Herceus standing under it. The propylea are nearly in a line with the space dividing it from the parthenon; which disposition, besides its other effects, occasioned the front and flank of the latter edifice to be seen at once by those who approached it from the entrance of the acropolis.

19 Of Jupiter Olympius.

"The ruin of the temple of Jupiter Olympius consists of prodigious columns, tall and beautiful, of the Corinthian order, fluted; some single, some supporting the architraves; with a few massive marbles beneath: the remnant of a vast heap, which only many ages could have consumed and reduced into so scanty a compass. The columns are of very extraordinary dimensions, being about six feet in diameter, and near 60 in height. The number without the cell was 116 or 120. Seventeen were standing in 1676: but a few years before we arrived, one was overturned with much difficulty, and applied to the building a new mosque in the bazar or market-place. This violence was avenged by the bashaw of Negropont, who made it a pretext for extorting from the vaiwode or governor 15 purses; the pillar being, he alledged, the property of their master the Grand Signior. It was an angular column, and of consequence in determining the dimensions of the fabric. We regretted that the fall of this mighty mass had not been postponed until we came, as it would have afforded an opportunity of inspecting and measuring some members which we found far too lofty to be attempted. On a piece of the architrave, supported by a couple of columns, are two parallel walls, of modern masonry, arched about the middle, and again near the top. You are told it has been the habitation of a hermit, doubtless of a stylite; but for whatever building it has been part, and for whatever purpose designed, it must have been erected thus high in air, while the immense ruin of this huge structure was yet scarcely diminished, and the heap inclined so as to render it accessible. It was remarked that two stones of a step in the front had coalesced at the extremity, so that no juncture could be perceived; and the like was discovered also in a step of the parthenon. In both instances it may be attributed to a concretory fluid, which pervades the marble in the quarry. Some portion remaining in the pieces, when taken green as it were, and placed in mutual contact, it exuded and united them by a process similar to that in a bone of an animal when broken and properly set.

20 Detached pieces of antique sculpture, &c.

"Besides the more stable antiquities, many detached pieces are found in the town, by the fountains, in the streets, the walls, the houses, and churches. Among these are fragments of sculpture; a marble chair or two, which probably belonged to the gymnasia or theatres: a sun-dial at the catholicon or cathedral, inscribed with the name of the maker; and, at the archiepiscopal house close by, a very curious vessel of marble, used as a cistern to receive water, but once serving, it is likely, as public standard or measure. Many columns occur; with some maimed statues; and pedestals, several with inscriptions, and almost buried in earth. A custom has prevailed, as at Chios, of fixing in the wall, over the gateways and doors of the houses, carved stones, most of which exhibit the funeral supper. In the courts of the houses lie many round stylæ, or pillars, once placed on the graves of the Athenians; and a great number are still to be seen applied to the same use in the Turkish burying grounds before the acropolis. These generally have concise inscriptions containing the name of the person, and of the town and tribe to which the deceased belonged. Demetrius the Phalerian, who endeavoured to restrain sepulchral luxury, enacted, that no person should have more than one, and that the height should not exceed three cubits. Another species, which resembles our modern head stones, is sometimes adorned with sculpture, and has an epitaph in verse. We saw a few mutilated Hermæ. These were busts on long quadrangular bases, the heads frequently of brass, invented by the Athenians. At first they were made to represent only Hermes or Mercury, and designed as guardians of the sepulchres in which they were lodged; but afterwards the houses, streets, and porticoes of Athens were adorned with them, and rendered venerable by a multitude of portraits of illustrious men and women, of heroes, and of gods: and, it is related, Hipparchus, son of Pisistratus, erected them in the demi or borough towns, and by the road side, inscribed with moral apophthegms in elegiac verse; thus making them vehicles of instruction."

ATHERINA. See Ichthyology *Index*.

ATHEROMA, in *Surgery*, a tumor without pain or discoloration of the skin, containing, in a membranous bag, matter resembling pap, intermixed with hard and stony particles. These tumors are usually cured by incision.

ATHERTON, or Atherston, a town of Warwickshire in England, situated on the river Stour, in W. Long. 1. 30. N. Lat. 52. 40. It is a considerable town, and had formerly a monastery; but now is best known by its fair, which is the greatest in England for cheese.

ATHESIS, in *Ancient Geography*, a river of the Cisalpine Gaul, which, rising in the Rhetian Alps, in Mount Brenna, in the county of Tirol, runs southwards and washes Tridentum and Verona, which last it divides; and after passing this, bends its course eastwards, in a parallel direction with the Po, and falls into the Adriatic between Fossa Claudia and Philistina: it separated the Euganei, an ancient people from the Veneti. The people dwelling on it are called *Athesini* (Pliny). Its modern name is the *Adige*.

ATHLETÆ, in *Antiquity*, persons of strength and agility, disciplined to perform in the public games. The word is originally Greek, αθλητης: formed from αθλος, *certamen*, "combat;" whence also αθλον, the prize or reward adjudged the victor.—Under athletæ were comprehended wrestlers, boxers, runners, leapers, throwers

throwers of the diſk, and thoſe practiſed in other exerciſes exhibited in the Olympic, Pythian, and other ſolemn ſports; for the conquerors wherein there were eſtabliſhed prizes.

ATHLETIC HABIT, denotes a ſtrong hale conſtitution of body. Anciently it ſignified a full fleſhy corpulent ſtate, ſuch as the athletæ endeavoured to arrive at. The athletic habit is eſteemed the higheſt pitch of health: yet it is dangerous, and the next door to diſeaſe; ſince, when the body is no longer capable of being improved, the next alteration muſt be for the worſe. The chief object of the athletic diet, was to obtain a firm, bulky, weighty body; by force of which, more than art and agility, they frequently overpowered their antagoniſt: hence they fed altogether on dry, ſolid, and viſcous meats. In the earlier days, their chief food was dry figs and cheeſe, which was called *arida ſaginatio*, ξηρα τροφη, and Ασκησις διαξηδων ις χαδων. Oribaſius, or, as others ſay, Pythagoras, firſt brought this into diſuſe, and ſubſtituted fleſh in lieu thereof. They had a peculiar bread called κολητια: They exerciſed, ate, and drank, without ceaſing: they were not allowed to leave off eating when ſatiated; but were obliged to cram on till they could hold no more; by which means they at length acquired a degree of voracity which to us ſeems incredible, and a ſtrength proportional. Witneſs what Pauſanias relates of the four celebrated athletæ, Polydamus the Theſſalian, Milo the Crotonian, Theagenes the Thaſian, and Euthymus the Locrian: The ſecond is ſaid to have carried a bull on his back a conſiderable way, then to have knocked him down with a blow of his fiſt, and laſtly, as ſome add, devoured him at a meal.

ATHLONE, a town of Weſtmeath in Ireland, lying in W. Long. 8. 0. N. Lat. 53. 20. It is ſituated on both ſides of the Shannon, and both parts are united by a ſtrong, high-raiſed, and well-built bridge, in the middle of which ſtands a monument, with ſome figures cut in marble, together with Queen Elizabeth's arms, and ſome inſcriptions declaring the time and the founders of the building. The caſtle was founded by King John on ſome land belonging to St Peter's abbey, for which he granted a compenſation. It is built on a high-raiſed round hill, reſembling one of the Daniſh raths or forts. Here were formerly two convents or monaſteries. Athlone was formerly ſtrongly fortified, and conſidered as of very great importance. In the year 1691, a part of the Engliſh army under General Ginckle, in the very face of the Iriſh who were ſtrongly intrenched on the oppoſite ſhore, fording the river, formed, and took poſſeſſion of the town, not loſing more than 50 men in the attack; which is eſteemed as bold and ſucceſsful an enterpriſe as any recorded in hiſtory. There are generally two troops of horſe and four companies of foot quartered at Athlone. This town gives the title *earl* to the family of Ginckle, as a reward for the noble ſervices performed by the general.

ATHOL, the moſt northern diſtrict of Perthſhire in Scotland, extending in length 43 miles, and in breadth 30. It is bordered on the north by Badenoch, on the weſt by Lochaber, on the eaſt and ſouth-eaſt by Mar and Gowrie, on the ſouth by Stratherne and Perth Proper, and on the ſouth-weſt by Braidalbane. The country is very rough and mountainous, and contains part of the ancient Caledonian foreſt; but theſe mountains are interſperſed with fruitful valleys. Here are ſeveral villages, but no towns of any conſideration. The moſt noted place is Blair-Caſtle, ſeated on the river Tilt, near its influx into the Gurry, a pleaſant limpid ſtream that falls in the Tay. This caſtle belongs to the duke of Athol, who derives his title from this diſtrict, and lives here with great magnificence. In the ſame neighbourhood we ſee the paſs of Gillicranky, rendered memorable by the battle fought here in the beginning of King William's reign, between that monarch's general M'Kay, and the Highlanders adhering to King James. See GILLICRANKY.

ATHOS, a celebrated mountain of Chalcidia in Macedonia, ſituated in E. Long. 26. 20. N. Lat. 40. 10. The ancients entertained extravagant notions concerning its height. Mela affirmed it to be ſo high as to reach above the clouds; and Martianus Capellinus, that it was ſix miles high. It was a received opinion that the ſummit of Mount Athos was above the middle region of the air, and that it never rained there; becauſe the aſhes left on the altars erected near its ſummit were always found as they were left, dry and unſcattered. But if on many accounts it was famous among the ancients, it is no leſs ſo among the moderns. The Greeks, ſtruck with its ſingular ſituation and the venerable appearance of its towering aſcent, erected ſo many churches, monaſteries, hermitages, &c. upon it, that it became in a manner inhabited by devotees, and from thence received the name of the *Holy Mountain;* which name it ſtill retains, though many of thoſe conſecrated works are now decayed. According to the accounts of modern travellers, this mountain advances into the Archipelago, being joined to the continent by an iſthmus about half a league in breadth. It is about 30 miles in circumference, and two in perpendicular height. It may be travelled over in about three days, and may be ſeen 90 miles off. There is a fine proſpect from the top; but, like all other high mountains, the cold on its ſummit is exceſſive. It abounds with many different kinds of plants and trees, particularly the pine and fir. In the valleys grows a plant called *elegia*, whoſe branches ſerve to make pens for writing. In ſhort, this mountain is ſaid to be adorned with variety of herbage and evergreens, a multitude of ſprings and ſtreams, and woods growing near the ſhore, ſo as to be one of the moſt agreeable places in the world.

It is now inhabited by Caloyers, a ſort of Greek monks, of the order of St Baſil, who never marry, though others of that church do. They abſtain from fleſh, and fare very hardly, their ordinary meal being olives pickled when they are ripe. They are about 6000 in all, and inhabit ſeveral parts of the mountain, on which are 24 large old monaſteries, ſurrounded with high walls for a defence againſt banditti. They are ſo reſpected, that the Turks themſelves will often ſend them alms. Theſe monks are not idle like others; but labour with the axe, ſpade, and ſickle, dreſſing themſelves like hermits. Formerly they had fine Greek manuſcripts; but are now become ſo illiterate, that they can ſcarce read or write.

Through this mountain, or rather through the iſthmus behind it, Xerxes king of Perſia is ſaid to have cut

cut a paſſage for his fleet when about to invade Greece. In this work he ſpent three whole years, and employed in it all the forces on board the fleet. He is alſo ſaid, before the work was begun, to have written the following inſolent and ridiculous letter to the mountain: "Athos, thou proud and aſpiring mountain, that lifteſt up thy head to the very ſkies, I adviſe thee not to be ſo audacious as to put rocks and ſtones that cannot be cut in the way of my workmen. If thou makeſt that oppoſition, I will cut thee entirely down, and throw thee headlong into the ſea." The directors of this enterpriſe are ſaid to have been Bubaris the ſon of Megabyzus, and Artacheus, the ſon of Arbeus, both Perſians; but as no traces of ſuch a great work remain, the truth of the whole relation has juſtly been called in queſtion.

ATHWART, in *Navigation*, is ſynonymous with acroſs the line of the courſe.

Athwart the Fore-foot, is a phraſe that denotes the flight of a cannon ball from one ſhip acroſs the courſe of another, to intercept the latter, and oblige her to ſhorten ſail, that the former may come near enough to examine her.

Athwart-Hauſe, expreſſes the ſituation of a ſhip, when ſhe is driven by wind or tide, or any other accident, acroſs the fore part of another.

Athwart-Ships, reaching acroſs ſhips from one ſide to the other.

ATHY, a town of Ireland, in the county of Kildare, not far from the borders of Queen's county. W. Long. 7. 0. N. Lat. 53. 0. It is ſituated on the river Barrow; is governed by a ſovereign, two bailiffs, and a recorder; and is, alternately with Naas, the aſſizes town.

ATIBAR, the name by which the inhabitants of the kingdom of Gago in Africa call gold duſt; from which word, Europeans, and eſpecially the French, have compoſed the word *tibir*, which alſo ſignifies gold duſt among thoſe who trade in that commodity.

ATIGNY, an ancient town of Champagne in France, where ſeveral of the kings of France had their reſidence. It is ſeated on the river Arſne, in E. Long. 4. 47. N. Lat. 49. 30.

ATKINS, Sir Robert, lord chief baron of the exchequer, was born in 1621, and educated at the univerſity of Oxford, from whence he removed to the inns of court, and became eminent in the law. He was made knight of the Bath, with many other perſons of the firſt diſtinction, at the coronation of King Charles II. In 1672, he was appointed one of the judges of common pleas; in which honourable ſtation he continued till 1679, when, foreſeeing the troubles that ſoon after enſued, he thought fit to reſign, and retire into the country. In 1689, he was made by King William lord chief baron of the exchequer; and about the ſame time executed the office of ſpeaker to the houſe of lords, which had been previouſly refuſed by the marquis of Halifax. He diſtinguiſhed himſelf by an unſhaken zeal for the laws and liberties of his country. He wrote ſeveral pieces, which have been collected into one volume 8vo, under the title of *Parliamentary and Political Tracts*. The authors of the Biographia Britannica remark, that whoever inclines to be thoroughly informed of the true conſtitution of his country, of the grounds and reaſons of the revolution, and of the danger of ſuffering prerogative to joſtle law, cannot read a better or plainer book than thoſe tracts of Sir Robert Atkins. He died in 1709, aged 88.

Atkins, *Sir Robert*, ſon of the preceding, was born in 1646, and was eminent for all the virtues that could adorn an Engliſh gentleman. He wrote The Ancient and Preſent State of Glouceſterſhire, in one large volume in folio; and died October 29. 1711.

ATKYNS, Richard, was deſcended from a good family, and was born at Tuffleigh in Glouceſterſhire in the year 1615. He was educated at Oxford, from whence he removed to Lincoln's Inn, and afterwards diſtinguiſhed himſelf by his loyalty to King Charles I. for whom he raiſed a troop of horſe at his own expence. At the Reſtoration he was made one of the deputy lieutenants of Glouceſterſhire, and diſtinguiſhed himſelf by his attachment to the government. But at length being committed priſoner to the Marſhalſea in Southwark for debt, he died there on the 14th of September 1677. He wrote ſeveral pieces, particularly A Treatiſe on the Original and Growth of Printing.

ATLANTIC ocean, that bounded by Europe and Africa on the eaſt, and by America on the weſt.

ATLANTICA. See Atlantis.

ATLANTIDES, in *Aſtronomy*, a denomination given to the Pleiades, or ſeven ſtars, ſometimes alſo called *Vergilliæ*. They are thus called, as being ſuppoſed by the poets to have been the daughters either of Atlas or his brother Heſperus, who were tranſlated into heaven.

ATLANTIS, Atalantis, or Atlantica, an iſland mentioned by Plato and ſome others of the ancients, concerning the real exiſtence of which many diſputes have been raiſed. Homer, Horace, and the other poets, make two Atlanticas, calling them *Heſperides* and *Elyſian Fields*, making them the habitations of the bleſſed. The moſt diſtinct account of this iſland we have in Plato's Timæus, of which Mr Chambers gives the following abridgement. "The Atlantis was a large iſland in the weſtern ocean, ſituated before or oppoſite to the ſtraits of Gades. Out of this iſland there was an eaſy paſſage into ſome others, which lay near a large continent exceeding in bigneſs all Europe and Aſia. Neptune ſettled in this iſland (from whoſe ſon Atlas its name was derived), and divided it among his ten ſons. To the youngeſt fell the extremity of the iſland, called *Gadir*, which in the language of the country ſignifies *fertile*, or *abundant in ſheep*. The deſcendants of Neptune reigned here from father to ſon for a great number of generations in the order of primogeniture, during the ſpace of 9000 years. They alſo poſſeſſed ſeveral other iſlands; and, paſſing into Europe and Africa, ſubdued all Libya as far as Egypt, and all Europe to Aſia Minor. At length the iſland ſunk under water; and for a long time afterwards the ſea thereabouts was full of rocks and ſhelves."

Many of the moderns alſo are of opinion, that the exiſtence of the Atlantis is not to be looked upon as entirely fabulous. Some take it to have been America; and from thence, as well as from a paſſage in Seneca's Medea, and ſome other obſcure hints, they imagine that the new world was not unknown to the ancients. But allowing this to be the caſe, the abovementioned

Atlantis || Atlas.

mentioned continent, which was ſaid to lie beyond Atlantis, would ſeem rather to have been the continent of America than Atlantis itſelf. The learned Rudbeck, profeſſor in the univerſity of Upſal, in a work entitled *Atlantica ſive Manheim*, endeavours to prove that Sweden and Norway are the Atlantis of the ancients; but this its ſituation will by no means allow us to believe. By Kircher it is ſuppoſed to have been an iſland extending from the Canaries quite to the Azores; that it was really ſwallowed up by the ocean, as Plato aſſerts; and that theſe ſmall iſlands are the ſhattered remains of it which were left ſtanding.

Atlantis, *New*, is the name of a fictitious philoſophical commonwealth, of which a deſcription has been given by Lord Bacon.—The New Atlantis is ſuppoſed to be an iſland in the South ſea, to which the author was driven in a voyage from Peru to Japan. The compoſition is an ingenious fable, formed after the manner of the Utopia of Sir Thomas More, or Campanella's City of the Sun. Its chief deſign is to exhibit a model or deſcription of a college, inſtituted for the interpretation of nature and the production of great and marvellous works, for the benefit of men, under the name of *Solomon's Houſe*, or "the college of the ſix days work." This much, at leaſt, is finiſhed; and with great beauty and magnificence. The author propoſed alſo a frame of laws, or of the beſt ſtate or mould of a commonwealth. But this part is not executed.

ATLAS, king of Mauritania, a great aſtronomer, contemporary with Moſes. From his taking obſervations of the ſtars from a mountain, the poets feigned him to have been turned into a mountain, and to ſuſtain the heavens on his ſhoulders. Being an excellent aſtronomer, and the firſt who taught the doctrine of the ſphere, they tell us that his daughters were turned into ſtars: ſeven of them forming the Pleiades, and other ſeven the Hyades.

Atlas, a chain of mountains in Africa, lying between the 20th and 25th degree of north latitude, and ſuppoſed almoſt to divide the continent from eaſt to weſt. They are ſaid to have derived their name from Atlas king of Mauritania, who was a great aſtronomer. They are greatly celebrated by the ancients on account of their height, inſomuch that the above-mentioned king, who is ſaid to have been transformed into a mountain, was feigned to bear up the heavens on his ſhoulders. We are aſſured, however, by Dr Shaw, that the part of this chain of mountains which fell under his obſervation could not ſtand in competition either with the Alps or Apennines. He tells us, that if we conceive a number of hills, uſually of the perpendicular height of 400, 500, or 600 yards, with an eaſy aſcent, and ſeveral groves of fruit or foreſt trees, riſing up in a ſucceſſion of ranges above one another; and that if to this proſpect we add now and then a rocky precipice, and on the ſummit of each imagine a miſerable mud-walled village; we ſhall then have a juſt idea of the mountains of Atlas.

According to M. Chenier *, this mountain is formed by an endleſs chain of lofty eminences, divided into different countries, inhabited by a multitude of tribes, whoſe ferocity permits no ſtranger to approach. "I have not been able (continues he) to obtain a ſufficient knowledge of theſe mountains to deſcribe them accurately: What Leo Africanus has ſaid of them is very vague; and his account is the leſs to be regarded at preſent, as it is now about three centuries ſince he wrote, and the face of the country has been in that time totally changed. Nothing perhaps would be more intereſting to the curioſity of the philoſopher, or conduce more to the improvement of our knowledge in natural hiſtory, than a journey over Mount Atlas. The climate, though extremely cold in winter, is very healthy and pleaſant; the valleys are well cultivated, abound in fruits, and are diverſified by foreſts and plentiful ſprings, the ſtreams of which uniting at a little diſtance, form great rivers, and loſe themſelves in the ocean. According to the reports of the Moors, there are many quarries of marble, granite, and other valuable ſtone, in theſe mountains: It is probable there are alſo mines, but the inhabitants have no idea of theſe riches; they conſider their liberty, which their ſituation enables them to defend, as the moſt ineſtimable of all treaſures."

* *Hiſt. of Morocco*, I. 13.

Atlas || Atmoſphere.

Atlas, in *Matters of Literature*, denotes a book of univerſal geography, containing maps of all the known parts of the world.

Atlas, in *Commerce*, a ſilk-ſatin, manufactured in the Eaſt Indies. There are ſome plain, ſome ſtriped, and ſome flowered, the flowers of which are either gold or only ſilk. There are atlaſſes of all colours, but moſt of them falſe, eſpecially the red and the crimſon. The manufacture of them is admirable; the gold and ſilk being worked together after ſuch a manner as no workman in Europe can imitate; yet they are very far from having that fine gloſs and luſtre which the French know how to give to their ſilk ſtuffs. In the Chineſe manufactures of this ſort, they gild paper on one ſide with leaf-gold; then cut it in long ſlips, and weave it into their ſilks; which makes them, with very little coſt, look very rich and fine. The ſame long ſlips are twiſted or turned about ſilk threads, ſo artificially, as to look finer than gold thread, though it be of no greater value.

ATMOSPHERE, a word generally uſed to ſignify the whole maſs of fluid, conſiſting of air, aqueous and other vapours, electric fluid, &c. ſurrounding the earth to a conſiderable height.

1 Atmoſphere compoſed of two different fluids.

The compoſition of that part of our atmoſphere properly called *air*, was till lately very much unknown. In former times it was ſuppoſed to be a ſimple, homogeneous, and elementary fluid. The experiments of Dr Prieſtley diſcovered, that the pureſt kind of air, which he called *dephlogiſticated*, was in reality a compound, and might be artificially produced in various ways. His firſt conjectures concerning its component parts were, that it conſiſted of earth, nitrous acid, and phlogiſton. Subſequent experiments rendered theſe conjectures dubious; and at laſt it was ſuppoſed that dephlogiſticated air is a pure elementary ſubſtance, the vivifying principle to animals, and the acidifying principle throughout all nature. This dephlogiſticated air, however, is but a ſmall part of the compoſition of our atmoſphere. According to the moſt accurate computations, the air we uſually breathe is compoſed of only one-fourth of this dephlogiſticated air, or perhaps leſs; the other three or four parts conſiſting of what Dr Prieſtley calls *phlogiſticated*, and M. Lavoiſier *mephitic air*. This by itſelf is abſolutely noxious, and

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and exceedingly poisonous to animals: though it seems only to be negatively so; for when mixed in a certain proportion with dephlogisticated air, it may be breathed with safety, which could not be if it contained any ingredient absolutely unfriendly to the human constitution. The other part, viz. the pure dephlogisticated air, seems to stand much in the same relation to plants that phlogisticated air does to animals; that is, it would prove poisonous and destroy them if they were to depend upon it entirely for their subsistence; but as they derive their nourishment partly from the air and partly from the soil, it thence happens, that the plants which are set to grow in dephlogisticated air do not die instantly, as animals do in the phlogisticated kind, but remain for some time weak and sickly.

2 Phlogisticated air poisonous to animals, and dephlogisticated air to vegetables.

3 A great quantity of electric fluid contained in the atmosphere.

The other component parts of our atmosphere are so various, and of such heterogeneous natures, that they do not admit of any kind of definition or analysis, one only excepted, namely, the *electric fluid*. This we know pervades the whole, but appears to be much more copious in the upper than in the lower atmospherical regions. See Electricity. To measure the absolute quantity of this fluid, either in the atmosphere or any other substance, is impossible. All that we can know on this subject is, that the electric fluid pervades the atmosphere; that it appears to be more abundant in the superior than the inferior regions; that it seems to be the immediate bond of connection between the atmosphere and the water which is suspended in it; and that by its various operations, the phenomena of hail, rain, snow, lightning, and various other kinds of meteors, are occasioned.

4 Calculations of the height of the atmosphere.

Various attempts have been made to ascertain the height to which the atmosphere is extended all round the earth. These commenced soon after it was discovered, by means of the Torricellian tube, that air is a gravitating substance. Thus it also became known, that a column of air, whose base is a square inch, and the height that of the whole atmosphere, weighs 15 pounds: and that the weight of air is to that of mercury, as 1 to 10,800: whence it follows, that if the weight of the atmosphere be sufficient to raise a column of mercury to the height of 30 inches, the height of the aerial column must be 10,800 times as much, and consequently a little more than five miles high.

It was not, however, at any time supposed, that this calculation could be just; for as the air is an elastic fluid, the upper parts must expand to an immense bulk, and thus render the calculation above related exceedingly erroneous. By experiments made in different countries, it has been found, that the spaces which any portion of air takes up, are reciprocally proportional to the weights with which it is compressed. Allowances were therefore to be made in calculating the height of the atmosphere. If we suppose the height of the whole divided into innumerable equal parts, the density of each of which is as its quantity; and the weight of the whole incumbent atmosphere being also as its quantity; it is evident, that the weight of the incumbent air is everywhere as the quantity contained in the subjacent part; which makes a difference between the weights of each two contiguous parts of air. By a theorem in geometry, where the differences of magnitudes are geometrically proportional to the magnitudes themselves, these magnitudes are in continual arithmetical proportion; therefore, if, according to the supposition, the altitude of the air, by the addition of new parts into which it is divided, do continually increase in arithmetical proportion, its density will be diminished, or (which is the same thing, its gravity decreased) in continual geometrical proportion.

It is now easy, from such a series, by making two or three barometrical observations, and determining the density of the atmosphere at two or three different stations, to determine its absolute height, or its rarity, at any assignable height. Calculations accordingly were made upon this plan; but it having been found that the barometrical observations by no means corresponded with the density which, by other experiments, the air ought to have had, it was suspected that the upper parts of the atmospherical regions were not subject to the same laws with the lower ones. Philosophers therefore had recourse to another method for determining the altitude of the atmosphere, viz. by a calculation of the height from which the light of the sun is refracted, so as to become visible to us before he himself is seen in the heavens. By this method it was determined, that at the height of 45 miles the atmosphere had no power of refraction; and consequently beyond that distance was either a mere vacuum or the next thing to it, and not to be regarded.

5 Height of it determined from the beginning and end of twilight.

This theory soon became very generally received, and the height of the atmosphere was spoken of as familiarly as the height of a mountain, and reckoned to be as well ascertained, if not more so, than the heights of most mountains are. Very great objections, however, which have never yet been removed, arise from the appearances of some *meteors*, like large globes of fire, not unfrequently to be seen at vast heights above the earth (see Meteor). A very remarkable one of this kind was observed by Dr Halley in the month of March 1719, whose altitude he computed to have been between 69 and 73½ English miles; its diameter 2800 yards, or upwards of a mile and a half; and its velocity about 350 miles in a minute. Others, apparently of the same kind, but whose altitude and velocity were still greater, have been observed; particularly that very remarkable one, August 18th, 1783, whose distance from the earth could not be less than 90 miles, and its diameter not less than the former; at the same time that its velocity was certainly not less than 1000 miles in a minute. Fire-balls, in appearance similar to these, though vastly inferior in size, have been sometimes observed at the surface of the earth. Of this kind Dr Priestley mentions one seen on board the Montague, 4th November 1749, which appeared as big as a large millstone, and broke with a violent explosion.

6 Objection from the appearance of meteors.

From analogical reasoning, it seems very probable, that the meteors which appear at such great heights in the air are not essentially different from those which, like the fire-ball just mentioned, are met with on the surface of the earth. The perplexing circumstances with regard to the former are, that at the great heights above mentioned, the atmosphere ought not to have any density sufficient to support flame, or to propagate sound; yet these meteors are commonly succeeded by one or more explosions, nay are sometimes said to be accompanied with a hissing noise as they pass over our heads. The meteor of 1719 was not

 only

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only very bright, insomuch that for a short space it turned night into day, but was attended with an explosion heard over all the island of Britain, occasioning a violent concussion in the atmosphere, and seeming to shake the earth itself. That of 1783 also, though much higher than the former, was succeeded by explosions; and, according to the testimony of several people, a hissing noise was heard as it passed. Dr Halley acknowledged that he was unable to reconcile these circumstances with the received theory of the height of the atmosphere; as, in the regions in which this meteor moved, the air ought to have been 300,000 times more rare than what we breathe, and the next thing to a perfect vacuum.

In the meteor of 1783, the difficulty is still greater, as it appears to have been 20 miles farther up in the air. Dr Halley offers a conjecture, indeed, that the vast magnitude of such bodies might compensate for the thinness of the medium in which they moved. Whether or not this was the case cannot indeed be ascertained, as we have so few data to go upon; but the greatest difficulty is to account for the brightness of the light. Appearances of this kind are indeed with great probability attributed to electricity, but the difficulty is not thus removed. Though the electrical fire pervades with great ease the vacuum of a common air-pump, yet it does not in that case appear in bright well defined sparks, as in the open air, but rather in long streams resembling the aurora borealis. From some late experiments, indeed, Mr Morgan concludes, that the electrical fluid cannot penetrate a perfect vacuum *. If this is the case, it shows that the regions we speak of are not such a perfect vacuum as can be artificially made; but whether it is or not, the extreme brightness of the light shows that a fluid was present in those regions, capable of confining and condensing the electric matter as much as the air does at the surface of the ground; for the brightness of these meteors, considering their distance, cannot be supposed inferior to that of the brightest flashes of lightning.

* See *Electricity* Index.

7 Density of the air does not always keep pace with its gravity.

This being the case, it appears reasonable to conclude, that what is called the *density* of the air does not altogether keep pace with its gravity. The latter indeed must in a great measure be affected by the vapours, but above all by the quantity of the basis of fixed or dephlogisticated air contained in it: for Mr Kirwan has discovered that the basis of fixed air, when deprived of its elastic principle, is not greatly inferior to gold in specific gravity; and we cannot suppose that of dephlogisticated air to be much less. It is possible, therefore, that pure air, could it be deprived of all the water it contains, might have very little gravity; and as there is great reason to believe that the basis of dephlogisticated air is only one of the constituent parts of water we see an evident reason why the air ought to become lighter, and likewise less fit for respiration, the higher up we go, though there is a possibility that its density, or power of supporting flame, may continue unaltered.

There are not yet, however, a sufficient number of facts to enable us to determine this question; though such as have been discovered seem rather to favour the above conjecture. Dr Boerhaave was of opinion that the gravity of the air depended entirely on the water it contained; and, by the means of alkaline salts, he was enabled to extract as much water from a quantity of air as was very nearly equivalent to its weight. By the calcination of metals we may extract as much of the basis of dephlogisticated air from a quantity of atmospherical air as is equivalent to the weight of air lost. Were it possible, therefore, to extract the whole of this, as well as all other vapours, and to preserve only the elastic principle, it is highly probable that its gravity would entirely cease. It has been found by those who have ascended with aerostatic machines, or to the tops of high mountains, that the dephlogisticated air is found to be contained in smaller quantities in the atmosphere of those elevated regions than on the lower grounds. It is also found, that in such situations the air is much drier, and parts with water with much more difficulty, than on the ordinary surface. Salt of tartar, for instance, which at the foot of a mountain will very soon run into a liquid, remains for a long time exposed to the air on the top of it, without showing the least tendency to deliquesce. Nevertheless, it hath never been observed that fires did not burn as intensely on the tops of the highest mountains as on the plains. The matter indeed was put to the trial in the great eruption of Vesuvius in 1779, where, though the lava spouted up to the height of three miles above the level of the sea, the uppermost parts all the while were to appearance as much inflamed as the lowest.

8 Gravity of the upper regions of the atmosphere perhaps diminished by electricity.

The high degree of electricity, always existing in the upper regions of the atmosphere, must of necessity have a very considerable influence on the gravity of any heterogeneous particles floating in it. When we consider the effects of the electric fluid upon light bodies at the surface of the earth, it will readily be admitted, that in those regions where this fluid is very abundant, the gravity of the atmosphere may be much diminished without affecting its density. We know that it is the nature of any electrified substance to attract light bodies; and that, by proper management, they may even be suspended in the air, without either moving up or down for a considerable time. If this is the case with light terrestrial bodies, it cannot be thought very improbable that the aerial particles themselves, i. e. those which we call the basis of dephlogisticated air, and of aqueous or other vapour diffused among them, should be thus affected in the regions where electricity is so abundant. From this cause, therefore, also the gravity of the atmosphere may be affected without any alteration at all being made in its density; and hence may arise anomalies in the barometer hitherto not taken notice of.

9 Absolute height of the atmosphere undetermined.

It appears, therefore, that the absolute height of the atmosphere is not yet determined. The beginning and ending of twilight indeed show, that the height at which the atmosphere begins to refract the sun's light is about 44 or 45 English miles. But this may not improbably be only the height to which the aqueous vapours are carried: for it cannot be thought any unreasonable supposition, that light is refracted only by means of the aqueous vapour contained in the atmosphere; and that where this ceases, it is still capable of supporting the *electric* fire at least, as bright and strong as at the surface. That it does extend much higher, is evident from the meteors already mentioned: for all these are undoubtedly carried along with the atmosphere;

atmoſphere; otherwiſe that of 1783, which was ſeen for about a minute, muſt have been left 1000 miles to the weſtward, by the earth flying out below it in its annual courſe round the ſun.

10 Of the preſſure of the atmoſphere.

It has already been mentioned, that the preſſure of the atmoſphere, when in its mean ſtate, is equivalent to a weight of 15 pounds on every ſquare inch. Hence Dr Cotes computed, that the preſſure of the whole ambient fluid upon the earth's ſurface is equivalent to that of a globe of lead 60 miles in diameter. Hence alſo it appears, that the preſſure upon a human body muſt be very conſiderable; for as every ſquare inch of ſurface ſuſtains a preſſure of 15 pounds, every ſquare foot, as containing 144 inches, muſt ſuſtain a preſſure of 2160; and if we ſuppoſe a man's body to contain 15 ſquare feet of ſurface, which is pretty near the truth, he muſt ſuſtain a weight of 32,400 pounds, or 16 tun, for his ordinary load. By this enormous preſſure we ſhould undoubtedly be cruſhed in a moment, were not all parts of our bodies filled either with air or ſome other elaſtic fluid, the ſpring of which is juſt ſufficient to counterbalance the weight of the atmoſphere. But whatever this fluid may be, we are ſure that it is juſt able to counteract the atmoſpherical gravity and no more; for if any conſiderable preſſure be ſuperadded to that of the air, as by going into deep water, or the like, it is always ſeverely felt, let it be ever ſo equable. If the preſſure of the atmoſphere is taken off from any part of the human body, the hand, for inſtance, when put in an open receiver from whence the air is afterwards extracted, the weight of the atmoſphere then diſcovers itſelf, and we imagine the hand ſtrongly ſucked down into the glaſs. See Pneumatics.

11 Variation of the preſſure, and its effects.

In countries at ſome diſtance from the equator, the preſſure of the atmoſphere varies conſiderably, and thus produces conſiderable changes on many terreſtrial bodies. On the human body the quantity of preſſure ſometimes varies near a whole tun; and when it is thus ſo much diminiſhed, moſt people find ſomething of a liſtleſsneſs and inactivity about them. It is ſurpriſing, however, that the ſpring of the internal fluid, already mentioned, which acts as a counterpoiſe to the atmoſpherical gravity, ſhould in all caſes ſeem to keep pace with it when the preſſure is naturally diminiſhed, and even when it is artificially augmented, though not when the preſſure is artificially diminiſhed. Thus in that kind of weather when the preſſure of the air is leaſt, we never perceive our veins to ſwell, or are ſenſible of any inward expanſion in our bodies. On the contrary, the circulation is languid, and we ſeem rather to be oppreſſed by a weight.

12 Of difficulty of reſpiration on the tops of mountains.

Even in going up to the tops of mountains, where the preſſure of the atmoſphere is diminiſhed more than three times what it uſually is on the plain, no ſuch appearances are obſerved. Some travellers indeed have affirmed, that on the tops of very high mountains, the air is ſo light as to occaſion a great difficulty of reſpiration, and even violent retching and vomiting of blood. It does not appear, however, that theſe aſſertions are well founded. Mr Brydone found no inconvenience of this kind on the top of Mount Ætna; nor is any ſuch thing mentioned by Mr Houel, who alſo aſcended this mountain. Sir William Hamilton indeed ſays, that he did feel a difficulty of reſpiration, independent of any ſulphureous ſteam. But, on the top of a volcano, the reſpiration may be affected by ſo many different cauſes, that it is perhaps impoſſible to aſſign the true one. The French mathematicians, when on the top of a very high peak of the Andes, did not make any complaint of this kind, though they lived there for ſome time. On the contrary, they found the wind ſo extremely violent, that they were ſcarce able to withſtand its force; which ſeems an argument for at leaſt equal *denſity* of the atmoſphere in the ſuperior as in the inferior regions. Dr Heberden, who aſcended to the top of Teneriffe, a higher mountain than Ætna, makes no mention of any difficulty of reſpiration.

13 M. Sauſſure's ſymptoms on the top of Mount Blanc accounted for.

M. Sauſſure, however, in his journey to the top of Mount Blanc, the higheſt of the Alps, felt very great uneaſineſs in this way. His reſpiration was not only extremely difficult, but his pulſe became quick, and he was ſeized with all the ſymptoms of a fever. His ſtrength was alſo exhauſted to ſuch a degree, that he ſeemed to require four times as long a ſpace to perform ſome experiments on the top of the mountain as he would have done at the foot of it. It muſt be obſerved, however, that theſe ſymptoms did not begin to appear till he had aſcended two miles and a half perpendicular above the level of the ſea. The mountain is only about a quarter of a mile higher; and in this ſhort ſpace he was reduced to the ſituation juſt mentioned. But it is improbable that ſo ſmall a difference, even at the end of his journey, ſhould have produced ſuch violent effects, had not ſome other cauſe concurred. A cauſe of this kind he himſelf mentions, viz. that the atmoſphere at the top of the mountain was ſo much impregnated with fixed air, that lime-water, expoſed to it, quickly became covered with a pellicle occaſioned by the abſorption of that fluid. Now it is known, that fixed air is extremely pernicious to animals, and would bring on ſymptoms ſimilar to thoſe above mentioned. There is no reaſon, therefore, to have recourſe to the rarity of the atmoſphere for ſolving a phenomenon which may more naturally be accounted for otherwiſe.

When the preſſure of the atmoſphere is augmented, by deſcending, in the diving-bell, to conſiderable depths in the ſea, it does not appear that any inconvenience follows from its increaſe. Thoſe who ſit in the diving-bell are not ſenſible of any preſſure as long as they remain in the air, though they feel it very ſenſibly in going into the water: yet it is certain, that the preſſure in both caſes is the ſame: for the whole preſſure of the atmoſphere, as well as of the water, is ſuſtained by the air in the diving-bell, and conſequently communicated to thoſe who ſit in it.

But though artificial compreſſion of the air, as well as natural rarefaction, can thus be borne, it is otherwiſe with artificial rarefaction. Animals in an air-pump ſhow uneaſineſs from the very firſt, and cannot live for any time in an atmoſphere rarefied artificially even as much as it appeared to be from the barometer on the top of Mount Blanc.

14 Variation of the atmoſpherical preſſure accounted for.

It is not eaſy to aſſign the true reaſon of the variations of gravity in the atmoſphere. Certain it is, however, that they take place only in a very ſmall degree within the tropics; and ſeem there to depend on the heat of the ſun, as the barometer conſtantly ſinks near half an inch every day, and riſes again to its former ſtation

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station in the night time. In the temperate zones the barometer ranges from 28 to near 31 inches, by its various altitudes showing the changes that are about to take place in the weather. If we could know, therefore, the latent causes by which the weather is influenced, we should likewise certainly know those by which the gravity of the atmosphere is affected. In general they may be reduced to two, viz. an emission of latent heat from the vapour contained in the atmosphere, or of electric fluid from the same, or from the earth. To one or both of these causes, therefore, may we ascribe the variations of the gravity of the atmosphere; and we see that they both tend to produce the same effect with the solar heat in the tropical climates, viz. to rarefy the air, by mixing with it or setting loose a non-gravitating fluid, which did not act in such large proportion in any particular place before. No doubt, the action of the latent heat and electric fluid is the same in the torrid as in the temperate zones: but in the torrid zone the solar heat and excessive evaporation counteract them; so that whatever quantities may be discharged by the excessive deluges of rain, &c. which fall in those countries, they are instantly absorbed by the abundant fluid, and are quickly ready to be discharged again; while, in the temperate zones, the air becomes sensibly lighter, as well as warmer, by them for some time before they can be absorbed again.

15 Variation of the heat and cold of the atmosphere.

The variations of heat and cold to which the atmosphere is subject, have been the subject of much speculation. In general they seem to depend entirely upon the light of the sun reflected into the atmosphere from the earth; and where this deflection is deficient, even though the light should be present ever so much, the most violent degrees of cold are found to take place. Hence, on the tops of mountains, the cold is generally excessive, though by reason of the clearness of the atmosphere the light of the sun falls upon them in greater quantity than it can do on an equal space on the plain. In long winding passages also, such as the caverns of Ætna and Vesuvius, where the air has room to circulate freely, without any access of the sun, the cold is scarce tolerable; whence the use of these for cooling liquors, preserving meat, &c.

16 Lambert and De Luc's reasons for the cold on the tops of mountains.

The coldness of the atmosphere on the tops of mountains has been ascribed by M. Lambert and De Luc, to the igneous fluid, or elementary fire, being more rare in those elevated situations than on the plains. M. Lambert is of opinion that it is rarefied above by the action of the air, and that below it is condensed by its own proper weight. He considers fire as a fluid in motion, the parts of which are separable, and which is rarefied when its velocity is accelerated. He does not decide with regard to the identity of fire and light, though he seems inclined to believe it. M. de Luc compares elementary fire to a continuous fluid, whose parts are condensed by being mutually compressed. He denies that fire and light are the same; and maintains that the latter is incapable, by itself, of setting fire to bodies, though it does so by putting in motion the igneous fluid they contain; and that it acts with more force near the earth than at a distance from its surface, by reason of this fluid, which he calls a *heavy* and *elastic* one, being more condensed there than at a greater height.

17 M. Saussure's account.

M. Saussure, in treating of this subject in his account of the Alps, does not consider fire as a fluid so free and detached as to be able either to ascend with rapidity by its specific levity, or to condense itself sensibly by its proper weight. He supposes it to be united to bodies by so strict an affinity, that all its motions are determined, or at least powerfully modified, by that affinity. As soon therefore as fire, disengaged by combustion or by any other cause, endeavours to diffuse itself, all the bodies that come within the sphere of its activity endeavour to attract it; and they absorb such quantities of it as are in the direct ratio of their affinities with it, or in the inverse ratio of what is necessary for their equilibrium with the surrounding bodies. Now it does not appear that in this distribution the situation of places, with regard to the horizon, has any other influence than what they receive from the different currents produced by the dilatation of the air, and by the levity which that dilatation produces. The ascent of flame, smoke, &c. or of air heated in any way, persuaded the ancients that fire is possessed of absolute levity, by which it had a tendency to mount upwards. "But these effects (says he) are owing either to the levity of the fluid which constitutes flame, or to that of air dilated by heat: and not to the levity of the igneous fluid. I am, however, sufficiently convinced, that this fluid is incomparably lighter than air, though I do not believe that it possesses the power of ascending in our atmosphere by virtue of its levity alone.

18 Mr Bouguer's reasons for the cold on the top of the Andes.

"The celebrated Bouguer has demonstrated, by principles the most simple, and most universally adopted, that it is not necessary, in order to account for the diminution of heat on mountains, to have recourse to hypotheses that are at best doubtful. The following is his explanation of what was felt on the mountains of Peru.

"It was proper, in order to explain this subject, to insist on the short duration of the sun's rays, which cannot strike the different sides of mountains but for a few hours, and even this not always. A horizontal plain, when the sun is clear, is exposed at mid-day to the perpendicular and undiminished action of these rays, while they fall but obliquely on a plain not much inclined, or on the sides of a high pile of steep rocks. But let us conceive for a moment an insulated point, half the height of the atmosphere, at a distance from all mountains, as well as from the clouds which float in the air. The more a medium is transparent, the less heat it ought to receive by the immediate action of the sun. The free passage which a very transparent body allows to the rays of light, shows that its small particles are hardly touched by them. Indeed what impression could they make on it, when they pass through almost without obstruction? Light, when it consists of parallel rays, does not by passing through a foot of free atmospheric air, near the earth, lose an hundred thousandth part of its force. From this we may judge how few rays are weakened, or can act on this fluid, in their passage through a stratum of the diameter not of an inch or a line, but of a particle. Yet the subtility and transparency are still greater at great heights, as was obvious on the Cordilleras, when we looked at distant objects. Lastly, the grosser air is heated below by the contact or neighbourhood of bodies of greater density than itself, which it surrounds, and

and on which it rests; and the heat may be communicated by little and little to a certain distance. The inferior parts of the atmosphere by this means contract daily a very considerable degree of heat, and may receive it in proportion to its density or bulk. But it is evident that the same thing cannot happen at the distance of a league and a half or two leagues above the surface of the earth, although the light there may be something more active. The air and the wind therefore must at this height be extremely cold, and colder in proportion to the elevation.

"Besides, the heat necessary to life is not merely that which we receive every instant from the sun. The momentary degree of this heat corresponds to a very small part of that which all the bodies around us have imbibed, and by which ours is chiefly regulated. The action of the sun only serves to maintain nearly in the same state the sum of the total heat, by repairing through the day the loss it sustains through the night, and at all times. If the addition be greater than the loss, the total heat will increase, as it happens in summer, and it will continue to accumulate in a certain degree; but for the reasons already given, this accumulation cannot be very great on the top of a mountain, where the summit, which rises high, is never of great bulk. The lowest state of the thermometer in every place is always in proportion to the heat acquired by the soil; and that being very small on the top of a mountain, the quantity added to it by the sun during the day must be comparatively greater; and the accumulated heat will be more in a condition to receive increase in proportion to its distance from the degree which it cannot pass.

"Another particular observable on all the high places of the Cordilleras, and which depends on the same cause, is, that when we leave the shade, and expose ourselves to the sunshine, we feel a much greater difference than we do here in our fine days when the weather is temperate. Every thing contributes at Quito to make the sun exceedingly powerful: a single step from an exposed place to the shade gives the sensation of cold: this would not be the case if the quantity of heat acquired by the soil were more considerable. We now also see why the same thermometer, put first into the shade and then in the sun, does not undergo the same changes at all times and in all places. In the morning, upon Pichincha, this instrument is generally a few degrees below the freezing point, which may be reckoned the natural temperature of the place; but when during the day we expose it to the sun, it is easy to imagine that the effect must be great, and much more than double in whatever way it is measured."

19 Burning-glasses equally powerful on the tops of mountains as on plains.

This theory is adopted by M. Saussure, who adds the following fact to prove that the action of the sun's rays, considered abstractedly and independent of any extrinsic source of cold, is as great on mountains as on plains; viz. that the power of burning lenses and mirrors is the same at all heights. To ascertain this fact, our author procured a burning-glass so weak that at Geneva it would just set fire to tinder. This he carried, with some of the same tinder, to the top of the mountain Saleve (a height of 3000 feet); where it not only produced the same effect, but apparently with greater facility than on the plain. Being persuaded then, that the principal source of cold on the tops of high mountains is their being perpetually surrounded with an atmosphere which cannot be much heated either by the rays of the sun on account of its transparency, or by the reflection of them from the earth by reason of its distance, he wished to know, whether the direct solar rays on the top of a high mountain had the same power as on the plain, while the body on which they acted was placed in such a manner as to be unaffected by the surrounding air. For this purpose he instituted a set of experiments, from which he drew the following conclusions, viz. that a difference of 777 toises in height, diminishes the heat which the rays of the sun are able to communicate to a body exposed to the external air, 14° of the thermometer; that it diminishes the heat of a body partially exposed, only 6°; and that it augments by 1° the heat of a third body completely defended from the air.

20 Atmosphere everywhere counteracts the heat of the sun.

Hence it appears that the atmosphere, though so essentially necessary to the support of fire, is somehow or other the greatest antagonist of heat, and most effectually counteracts the operation of the solar rays in producing it. This power it seems to exert at all distances, at the surface as well as in the higher regions. From some experiments made by M. Pictet it appears, that even in places exposed to the rays of the sun, the heat, at five feet distance from the ground, is greater only by one or two degrees than at 50 feet above the surface, though the ground was at that time 15 or 20° warmer than the air immediately in contact with it. Inconsiderable as this difference is, however, it does not hold as we go higher up; for if it did, the cold on the top of the mountain of Saleve, which is 3000 feet above the level of the lake of Geneva, would be 60° greater than at the foot of it; whereas in reality it is only 10°. In the night-time the case is reversed; for the stratum of air, at five feet from the ground, was found by M. Pictet to be colder than at 50. Besides this, different strata of the atmosphere are found to possess very different and variable degrees of cold, without any regard to their situation high up or low down.

21 Is colder very near the surface of the ground than at some distance.

In the year 1780, Dr Wilson of Glasgow found a very remarkable cold existing close to the surface of the ground; so that the thermometer, when laid on the surface of the snow, sunk many degrees lower than one suspended 24 feet above it. It has been likewise observed, that in clear weather, though the surface of the earth be then most liable to be heated by the sun, yet after that is set, and during the night, the air is coldest near the ground, and particularly in the valleys.

22 Mr Sex's experiments on this subject.

Experiments on this subject were made for a whole year by Mr James Sex, who has given an account of them in the 78th volume of the Philosophical Transactions. He suspended thermometers (constructed in such a manner as to show the true maximum and minimum of heat that might take place in the observer's absence) in a shady northerly aspect, and at different heights in the open air. One of these was placed at the height of 9 feet, and the other at that of 220 from the ground; and the observations were continued, with only a few days omission, from July 1784 to July 1785. The greatest variations of heat were in the months of October and June; in the former the thermometers generally differed most in the night, and in the latter mostly in the day. From the 25th to the

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28th of October, the heat below, in the night-time, exceeded in a small degree the heat above; at which time there was frequent rain mingled with hail. From the 11th to the 14th, and also on the 31st, there was no variation at all; during which time likewise the weather was rainy; all the rest of the month proving clear, the air below was found colder than that above, sometimes by nine or ten degrees. In the month of June, the greatest variations took place from the 11th to the 15th, and from the 25th to the 30th; and at both these times there appeared to be two currents of wind, the upper from the south-west and the lower from the north east. Sometimes these were rendered visible by clouds, in different strata, moving in different directions; and sometimes by clouds moving in a contrary direction to a very sensible current of air below. On cloudy nights the lowest thermometer sometimes showed the heat to be a degree or two greater than the upper one; but in the daytime the heat below constantly exceeded that above more than in the month of October.

To determine whether the nocturnal refrigeration was augmented by a nearer approach to the earth, two thermometers were placed in the midst of an open meadow, on the bank of the river near Canterbury. One was placed on the ground, and the other only six feet above it. The thermometer, at six feet distance from the ground, agreed nearly with the former at nine feet; but the nocturnal variations were found to correspond entirely with the clearness or the cloudiness of the sky: and though they did not always happen in proportion to their respective altitudes, yet when the thermometers differed in any respect, that on the ground always indicated the greatest degree of cold.

The difference betwixt these two thermometers, at the small distance of six feet from each other, being found no less than three degrees and a half, the number of thermometers in the meadow was augmented to four. One was sunk in the ground, another placed just upon it, and the third suspended at three feet above it. Three others were placed on a rising ground where the land was level with the cathedral tower, and about a mile distance from it. One of these was likewise sunk in the ground, another placed just upon it, and a third suspended six feet above it. With these seven thermometers, and the two first mentioned, which were placed in the city, he continued his observations for 20 days; but as the weather happened to be cloudy during the whole of that space, excepting for seven or eight days, no considerable variation happened excepting on these days. The result of the experiments was, that the cold was generally greater in the valley than on the hill; but the variations between the thermometers on the ground and those six feet above them, were often as great on the hill as in the valley.

Thus it was perceived that a difference of temperature took place at the distance of only three feet from the ground; but the length of the thermometers hitherto made use of rendered it impossible to make any experiment at a smaller distance. Two new ones, therefore, were formed by bending down the large tube, the body or bulb of the thermometer, to a horizontal position, while the stem remained in a vertical one; by which method the temperature might be observed to the distance of a single inch. Sometimes, in clear weather, these two horizontal thermometers were placed in the open air, one within an inch of the ground, and the other nine inches above it. When the variation among the other thermometers was considerable, a difference was likewise perceived between these; the lower one sometimes indicating more than two degrees less heat than the upper one, though placed so near each other.

23 His conclusions from these experiments.

From these experiments Mr Sex concludes, that a greater diminution of heat frequently takes place near the earth in the night-time than at any altitude in the atmosphere within the limits of his inquiry, that is, 220 feet from the ground; and at such times the greatest degrees of cold are always met with nearest the surface of the earth.

This is a constant and regular operation of nature under certain circumstances and dispositions of the atmosphere, and takes place at all seasons of the year; and this difference never happens in any considerable degree but when the air is still, and the sky perfectly unclouded. The moistest vapour, as dews and fogs, did not at all impede, but rather promote, the refrigeration. In very severe frosts, when the air frequently deposites a quantity of frozen vapour, it is commonly found greatest; but the excess of heat which in the day-time was found at the lowest station in summer, diminished in winter almost to nothing.

24 Mr Darwin's experiments on cold produced by the rarefaction of air.

It has been observed, that a thermometer, included in a receiver, always sinks when the air begins to be rarefied. This has been thought to arise, not from any degree of cold thus produced, but from the sudden expansion of the bulb of the thermometer in consequence of the removal of the atmospherical pressure: But from some late experiments related, Phil. Trans. vol. lxxviii. by Mr Darwin, it appears that the atmosphere always becomes warm by compression, and cold by dilatation from a compressed state. These experiments were,

1. The blast from an air-gun was repeatedly thrown upon the bulb of a thermometer, and it uniformly sunk it about two degrees. In making this experiment, the thermometer was firmly fixed against a wall, and the air-gun, after being charged, was left for an hour in its vicinity, that it might previously lose the heat it had acquired in the act of charging; the air was then discharged in a continued stream on the bulb of the thermometer, with the effect already mentioned.

2. A thermometer was fixed in a wooden tube, and so applied to the receiver of an air-gun, that, on discharging the air by means of a screw pressing on the valve of the receiver, a continued stream of air, at the very time of its expansion, passed over the bulb of the thermometer. This experiment was four times repeated, and the thermometer uniformly sunk from five to seven degrees. During the time of condensation there was a great difference in the heat, as perceived by the hand, at the two ends of the condensing syringe: that next the air-globe was almost painful to the touch; and the globe itself became hotter than could have been expected from its contact with the syringe. "Add to this (says Mr Darwin), that in exploding an air-gun the stream of air always becomes visible, which is owing

owing to the cold then produced, precipitating the vapour it contained; and if this ſtream of air had been previouſly more condenſed, or in greater quantity ſo as not inſtantly to acquire heat from the common atmoſphere in its vicinity, it would probably have fallen in ſnow.

3. A thermometer was placed in the receiver of an air-pump, and the air being haſtily exhauſted, it ſunk two or three degrees; but after ſome minutes regained its former ſtation. The experiment was repeated with a thermometer open at the top, ſo that the bulb could not be affected by any diminution of the external preſſure; but the reſult was the ſame. Both during exhauſtion and re-admiſſion of the air into the receiver, a ſteam was regularly obſerved to be condenſed on the ſides of the glaſs; which, in both caſes, was in a few minutes reabſorbed, and which appeared to be precipitated by being deprived of its heat by the expanded air.

4. A hole, about the ſize of a crow-quill, was bored into a large air-veſſel placed at the commencement of the principal pipe of the water-works of Derby. There are four pumps worked by a water-wheel, the water of which is firſt thrown into the lower part of this air-veſſel, and riſes from thence to a reſervoir about 35 or 40 feet above the level; ſo that the water in this veſſel is conſtantly in a ſtate of compreſſion. Two thermometers were previouſly ſuſpended on the leaden air-veſſel, that they might aſſume the temperature of it, and as ſoon as the hole above-mentioned was opened, had their bulbs applied to the ſtream of air which iſſued out; the conſequence of which was, that the mercury ſunk ſome degrees in each. This ſinking of the mercury could not be aſcribed to any evaporation of moiſture from their ſurfaces, as it was ſeen both in exhauſting and admitting the air into the exhauſted receiver mentioned in the laſt experiment, that the vapour which it previouſly contained was depoſited during its expanſion.

5. There is a curious phenomenon obſerved in the fountain of Hiero, conſtructed on a very large ſcale, in the Chemniſcenſian mines in Hungary. In this machine the air, in a large veſſel, is compreſſed by a column of water 260 feet high: a ſtop-cock is then opened: and as the air iſſues with great vehemence, and in conſequence of its previous condenſation becomes immediately much expanded, the moiſture it contains is not only precipitated, as in the exhauſted receiver above mentioned, but falls down in a ſhower of ſnow, with icicles adhering to the noſe of the cock. See Phil. Tranſ. vol. lii.

25 His concluſions with regard to cold on the tops of mountains.

From this phenomenon, as well as the four experiments above related, Mr Darwin thinks "there is good reaſon to conclude, that in all circumſtances where air is mechanically expanded, it becomes capable of attracting the fluid matter of heat from other bodies in contact with it.

"Now (continues he), as the vaſt region of air which ſurrounds our globe is perpetually moving along its ſurface, climbing up the ſides of mountains, and deſcending into the valleys; as it paſſes along, it muſt be perpetually varying the degree of heat according to the elevation of the country it traverſes: for, in riſing to the ſummits of mountains, it becomes expanded, having ſo much of the preſſure of the ſuperincumbent atmoſphere taken away; and when thus expanded, it attracts or abſorbs heat from the mountains in contiguity with it; and, when it deſcends into the valleys, and is compreſſed into leſs compaſs, it again gives out the heat it has acquired to the bodies it comes in contact with. The ſame thing muſt happen to the higher regions of the atmoſphere, which are regions of perpetual froſt, as has lately been diſcovered by the aerial navigators. When large diſtricts of air, from the lower parts of the atmoſphere, are raiſed two or three miles high, they become ſo much expanded by the great diminution of the preſſure over them, and thence become ſo cold, that hail or ſnow is produced by the precipitation of the vapour: and as there is, in theſe high regions of the atmoſphere, nothing elſe for the expanded air to acquire heat from after it has parted with its vapour, the ſame degree of cold continues, till the air, on deſcending to the earth, acquires its former ſtate of condenſation and of warmth.

"The Andes, almoſt under the line, reſts its baſe on burning ſands; about its middle height is a moſt pleaſant and temperate climate covering an extenſive plain, on which is built the city of Quito; while its forehead is encircled with eternal ſnow, perhaps coeval with the mountain. Yet, according to the accounts of Don Ulloa, theſe three diſcordant climates ſeldom encroach much on each other's territories. The hot winds below, if they aſcend, become cooled by their expanſion; and hence they cannot affect the ſnow upon the ſummit; and the cold winds that ſweep the ſummit, become condenſed as they deſcend, and of temperate warmth before they reach the fertile plains of Quito."

Notwithſtanding all theſe explanations, however, ſeveral very conſiderable difficulties remain with regard to the heat and cold of the atmoſphere. That warm air ſhould always aſcend; and thus, when the ſource of heat is taken away by the abſence of the ſun, that the ſtratum of atmoſphere lying immediately next to the earth ſhould be ſomewhat colder than that which lies a little farther up; is not at all to be wondered at. We have an example ſomewhat ſimilar to this in the potter's kiln; where, after the veſſels have been intenſely heated for ſome time, and the fire is then withdrawn, the cooling always begins at bottom, and thoſe which ſtand lowermoſt will often be quite black, while all the upper part of the furnace and the veſſels next to it are of a bright red. It doth not, however, appear why ſuch degrees of cold ſhould take place at the ſurface of the earth as we ſometimes meet with. It is, beſides, no uncommon thing to meet with large ſtrata in the upper regions of the atmoſphere, remarkable for their cold, while others are warmer than thoſe at the ſurface; as we have been aſſured of by the teſtimony of ſeveral aerial navigators. It is alſo difficult to ſee why the air which has once aſcended, and become rarefied to an extreme degree, ſhould afterwards deſcend among a denſer fluid of ſuperior gravity, though indeed the atmoſpherical currents by which this fluid is continually agitated may have conſiderable effect in this way. See the article WINDS. 26 Difficulties ſtill remain on the ſubject.

For the quantity of water contained in the atmoſphere, ſee the articles HYGROMETER, CLOUDS, VA-

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pour, &c. For the cause of the elasticity of the atmosphere, see Elasticity; and for an explanation of its various operations, see Meteorology.

The uses of the atmosphere are so many and so various that it is impossible to enumerate them. One of the most essential is its power of giving life to vegetables, and supporting that of all animated beings. For the latter purpose, however, it is not in all places equally proper: we shall therefore conclude this article with some remarks on

27 Of the salubrity of the atmosphere.

The Salubrity of the Atmosphere.——The air on the tops of mountains is generally more salubrious than that in pits. Dense air indeed is always more proper for respiration than such as is more rare; yet the air on mountains, though much more rare, is more free from phlogistic vapours than that of pits. Hence it has been found, that people can live very well on the tops of mountains where the barometer sinks to 15 or 16 inches. M. de Saussure, in his journey upon the Alps, having observed the air at the foot, on the middle, and on the summits of various mountains, observes, that the air of the very low plains seems to be the less salubrious; that the air of very high mountains is neither very pure, nor upon the whole, seems so fit for the lives of men, as that of a certain height above the level of the sea, which he estimates to be about 200 or 300 toises, that is, about 430 or 650 yards.

Dr White, in the 68th volume of the Phil. Transf. giving an account of his experiments on air made at York, says, that the atmospherical air was in a very bad state, and indeed in the worst he had ever observed it, the 13th of September 1777; when the barometer stood at 30.30, the thermometer at 69°; the weather being calm, clear, and the air dry and sultry, no rain having fallen for above a fortnight. A slight shock of an earthquake was perceived that day.

The air of a bed-room at various times, viz. at night, and in the morning after sleeping in it, has been examined by various persons; and it has been generally found, that after sleeping in it the air is less pure than at any other time. The air of privies, even in calm weather, has not been found to be so much phlogisticated as might have been expected, notwithstanding its disagreeable smell.

From this and other observations, it is thought that the exhalations of human excrements are very little if at all injurious, except when they become putrid, or proceed from a diseased body; in which case they infect the air very quickly.

28 Dr Ingenhousz's experiments.

Dr Ingenhousz, soon after he left London, sent an account of his experiments made in the year 1779 upon the purity of the air at sea and other parts; which account was read at the Royal Society the 24th of April 1780, and inserted in the 70th vol. of the Phil. Transf. His first observations were made on board a vessel in the mouth of the Thames, between Sheerness and Margate, where he found that the air was purer than any other sort of common air he had met with before. He found that the sea-air taken farther from the land, viz. between the English coast and Ostend, was not so pure as that tried before; yet this inferior purity seems not to take place always. The Doctor's general observations, deduced from his numerous experiments, are, "That the air at sea, and close to it, is in general purer, and fitter for animal life, than the air on the land, though it seems to be subject to some inconsistency in its degree of purity with that of the land: That probably the air will be found in general much purer far from the land than near the shore, the former being never subject to be mixed with land air."

The Doctor in the same paper transcribes a journal of experiments, showing the degree of purity of the atmosphere in various places, and under different circumstances; which we shall insert here in an abridged manner.

29 His journal of the purity of the air in different places.

The method used in those experiments was to introduce one measure of common air into the eudiometer tube, and then one measure of nitrous air. The moment that these two sorts of elastic fluids came into contact, he agitated the tube in the water-trough, and then measured the diminution, expressing it by hundredth parts of a measure; thus, when he says, that such air was found to be 130, it signifies, that after mixing one measure of it with one of nitrous air, the whole mixed and diminished quantity was 130 hundredths of a measure, viz. one measure and 30 hundredths of a measure more.

"The different degrees of salubrity of the atmosphere, as I found it in general in my country house at Southal-Green, ten miles from London, from June to September, lay between 103 and 109. I was surprised when, upon my return to town to my former lodgings to Pall Mall Court, I found the common air purer in general in October than I used to find it in the middle of summer in the country; for on the 22d of October, at nine o'clock in the morning, the weather being fair and frosty, I found that one measure of common air, and one of nitrous air, occupied 100 subdivisions in the glass-tube, or exactly one measure. That very day, at two o'clock in the afternoon (it being then rainy weather), the air was somewhat altered for the worse. It gave 102. October the 23d, it being rainy weather, the air gave 102. October the 24th, the weather being serene, the air at nine o'clock in the morning gave 100. October the 25th, the sky being cloudy at 11 o'clock in the morning, the air gave 102. At 11 o'clock at night, from five different trials, it gave 105. October the 26th, the weather being very dark and rainy, the air gave 105, as before."

The air at Ostend was found by the Doctor to be generally very good, giving between 94 and 98. At Bruges, the air taken at seven o'clock at night gave 103. November the 8th, the air at Ghent at three in the afternoon gave 103.

November the 12th, the air of Brussels at seven o'clock P. M. gave 105½. The next day the air of the lower part of the same city gave 106; that of the highest appeared to be purer, as it gave 104: which agrees with the common popular observation. November the 14th, both the air of the highest and that of the lowest part of the city appeared to be of the same goodness, giving 103. The weather was frosty.

November the 22d, the air of Antwerp in the evening gave 109½; the weather being rainy, damp, and cold. November the 23d, the air of Breda gave 106. The next day about 11 o'clock the air gave 102; the weather being fair, cold, and inclining to frost. At

seven

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seven o'clock it gave 103. Next day being the 25th, the air gave 104; the weather being cold and rainy. The 26th it gave 103; the weather being very rainy, cold, and stormy. November the 27th, the air at the Moordyke close to the water gave 101¼; the weather being fair and cold, but not frosty. This spot is reckoned very healthy. November the 28th, the air of Rotterdam gave 103; the weather being rainy and cold. November the 29th, the air of Delft gave 103; the weather being stormy and rainy.

November the 30th, the air of the Hague gave 104; the weather being cold, and the wind northerly. The first of December the weather underwent a sudden change; the wind becoming southerly and stormy, and the atmosphere becoming very hot. The day after, Fahrenheit's thermometer stood at 54°; and the common air being repeatedly and accurately tried gave 116; and that preserved in a glass phial from the preceding day gave 117; and that gathered close to the sea gave 115.

December the 4th, the air of Amsterdam gave 103; the weather being rainy, windy, and cold. The day after, the weather continuing nearly the same, the air gave 102. December the 10th, the air of Rotterdam gave 101; the weather being rainy. December the 12th, being in the middle of the water between Dort and the Moordyke, the air gave 109; the weather being remarkably dark, rainy, and windy. December the 13th, the air of Breda in the morning gave 109; the weather continuing as the day before. And in the afternoon, the air gave 106½; the weather having cleared up. December the 16th, the air of the lower part of the city of Antwerp gave 105, that of the higher part 104; the weather being rainy and temperate. December the 17th, the air of Antwerp gave 107; the weather continuing nearly as in the preceding day. December the 19th, the air of Brussels gave 109; the weather being rainy, windy, and rather warm. December the 21st, the air of Brussels gave 106; the weather being dry and cold. The next day the air and the weather continued the same. December the 23d, the air of Mons gave 104; the weather being rainy and cold. December the 24th, the air near Bochain gave 104½; the weather being cloudy and cold. December the 25th, the air of Peronne gave 102½; the weather being frosty. December the 26th, the air of Cuvilli gave 103; the weather frosty. December the 27th, the air of Senlis gave 102½; the weather frosty. December the 29th, the air of Paris gave 103; the weather frosty. 1780, January the 8th, the air of Paris gave 100; the weather frosty. January the 13th, the air of Paris gave 98; hard frost.

30 Apparatus with which his experiments were made.

Thus far with Dr Ingenhousz's observations. His apparatus was a very portable one, made by Mr Martin, which in reality is the eudiometer-tube and measure as used by Mr Fontana before he made his last improvement. "The whole of this apparatus (says Dr Ingenhousz was packed up in a box about ten inches long, five broad and three and half high. The glass-tube or great measure, which was 16 inches long, and divided into two separate pieces, lay in a small compass, and could be put together by brass screws adapted to the divided extremities. Instead of a water trough, such as is used commonly, I made use of a small round wooden tub," &c.

31 Fontana's opinions on the subject.

The Abbé Fontana, who has made a great number of very accurate experiments upon this subject, gives his opinion in the following words: "I have not the least hesitation in asserting, that the experiments made to ascertain the salubrity of the atmospherical air in various places in different countries and situations, mentioned by several authors, are not to be depended upon; because the method they used was far from being exact (A), the elements or ingredients for the experiment were unknown and uncertain, and the results very different from one another.

"When all the errors are corrected, it will be found that the difference between the air of one country and that of another, at different times, is much less than what is commonly believed: and that the great differences found by various observers are owing to the fallacious effects of uncertain methods. This I advance from experience; for I was in the same error. I found very great differences between the results of the experiments of this nature which ought to have been similar; which diversities I attributed to myself, rather than to the method I then used. At Paris I examined the air of different places at the same time, and especially of those situations where it was most probable to meet with infected air, because those places abounded with putrid substances and impure exhalations; but the differences I observed were very small, and much less than what could have been suspected, for they hardly arrived at one fiftieth of the air in the tube. Having taken the air of the hill called *Mount Valerian*, at the height of about 500 feet above the level of Paris, and compared it with the air of Paris taken at the same time, and treated alike, I found the former to be hardly one-thirtieth better than the latter.

"In London I have observed almost the same. The air of Islington and that of London suffered an equal diminution by the mixture of nitrous air; yet the air of Islington is esteemed to be much better. I have examined the air of London taken at different heights (for instance, in the street, at the second floor, and at the top of the adjoining houses), and have found it to be of the same quality. Having taken the air at the iron gallery of St Paul's cupola, at the height of 313 feet above the ground, and likewise the air of the stone gallery, which is 202 feet below the other; and having compared these two quantities of air with that of the street adjoining, I found that there was scarce any sensible difference between them, although taken at such different heights.

"In this experiment a circumstance is to be considered, which must have contributed to render the above-mentioned differences more sensible: that is, the agitation of the air of the cupola; for there was felt a pretty brisk wind upon it, which I observed to be stronger and stronger the higher I ascended; whereas in

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(A) It is plain that Dr Ingenhousz's method is not implied in this remark; since the Doctor's experiments were made long after, and the method used by him was properly that of Mr Fontana.

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in the street, and indeed in all the streets I passed through, there was no sensible wind to be felt. This experiment was made at four in the afternoon, the weather being clear. The quicksilver in the barometer at that time was 28,6 inches high, and Fahrenheit's thermometer stood at 54°."

A few lines after, Mr Fontana proceeds thus:—— "From this we clearly see, how little the experiments hitherto published about the differences of common air are to be depended upon. In general, I find that the air changes from one time to another; so that the differences between them are far greater than those of the airs of different countries or different heights. For instance, I have found that the air of London in the months of September, October, and November, 1778, when treated with the nitrous air, gave II, I, 1,90, and II, II, 2,25, which is a mean result of many experiments which differed very little from each other. The 26th day of November last, I found the air, for the first time, much better; for it gave II, I, 1,80, and II, II, 2,20; but the 14th of February 1779, the air gave II, I, 1,69 and II, II, 2,21; from whence it appears, that the air of this 14th of February was better than it had been six months before. There can be no doubt of the accuracy of the experiments, because I compared the air taken at different times with that which I had first used in the month of September, and which I had preserved in dry glass-bottles accurately stopped."

This difference in the purity of the air at different times, Mr Fontana farther remarks, is much greater than the difference between the air of the different places observed by him: notwithstanding this great change, as he observed, and as he was informed by various persons, no particular change of health in the generality of people, or facility of breathing, was perceived.

Mr Fontana lastly concludes with observing, that "Nature is not so partial as we commonly believe. She has not only given us an air almost equally good everywhere at every time, but has allowed us a certain latitude, or a power of living and being in health in qualities of air which differ to a certain degree. By this I do not mean to deny the existence of certain kinds of noxious air in some particular places; but only say, that in general the air is good everywhere, and that the small differences are not to be feared so much as some people would make us believe. Nor do I mean to speak here of some vapours and other bodies which are accidentally joined to the common air in particular places, but do not change its nature and intrinsical property. This state of the air cannot be known by the test of nitrous air; and those vapours are to be considered in the same manner as we should consider so many particles of arsenic swimming in the atmosphere. In this case it is the arsenic, and not the degenerated air, that would kill the animals who ventured to breathe it."

ATOCK, the capital of a province of the same name in the dominions of the Great Mogul. It is seated on a point of land where two large rivers meet, and is one of the best fortresses the Mogul has; but formerly nobody was permitted to enter it without a passport from the Mogul himself. E. Long. 72. 18. N. Lat. 32. 20.

ATOM, in *Philosophy*, a particle of matter, so minute, as to admit of no division. Atoms are the *minima naturæ*, and are conceived as the first principles or component parts of all physical magnitude.

ATOMICAL PHILOSOPHY, or the doctrine of atoms, a system which, from the hypothesis that atoms are endued with gravity and motion, accounted for the origin and formation of things. This philosophy was first broached by Moschus, some time before the Trojan war; but was much cultivated and improved by Epicurus; whence it is denominated the *Epicurean philosophy*. See EPICUREAN.

ATONEMENT. See EXPIATION.

ATONY, in *Medicine*, a defect of tone or tension, or a laxity or debility of the solids of the body.

ATOOI, one of the Sandwich islands, situated in W. Long. 160. 20. N. Lat. 21. 57. Towards the north-east and north-west, the face of the country is ragged and broken; but to the southward it is more even. The hills rise from the sea-side with a gentle acclivity, and at a little distance back are covered with wood. Its produce is the same with that of the other islands of this cluster; but its inhabitants greatly excel the people of all the neighbouring islands in the management of their plantations. In the low grounds, contiguous to the bay wherein our navigators* anchored, these plantations were regularly divided by deep ditches; the fences were formed with a neatness approaching to elegance; and the roads through them were finished in such a manner as would have reflected credit even on an European engineer.

* *Cook's Voyage.*

The island is about 300 miles in circumference. The road, or anchoring place, which our vessels occupied, is on the south-west side of the island, about two leagues from the west end, before a village named *Wymoa*. As far as was founded, the bank was free from rocks; except to the eastward of the vallage, where there projects a shoal on which are some rocks and breakers. This road is somewhat exposed to the trade-wind; notwithstanding which defect, it is far from being a bad station, and greatly superior to those which necessity continually obliges ships to use, in countries where the winds are not only more variable but more boisterous; as at Madeira, Teneriffe, the Azores, &c. The landing too is not so difficult as at most of those places; and, unless in very bad weather, is always practicable. The water in the neighbourhood is excellent, and may be conveyed with ease to the boats. But no wood can be cut at any convenient distance, unless the islanders could be prevailed upon to part with the few etooa trees (*cordia sebestina*) that grow about their villages, or a species called *dooe dooe*, which grows farther up the country. The ground, from the wooded part to the sea, is covered with an excellent kind of grass, about two feet in height, which sometimes grows in tufts, and appeared capable of being converted into abundant crops of fine hay. But on this extensive space not even a shrub grows naturally.

Besides taro, the sweet potato, and other similar vegetables used by our crews as refreshments, among which were at least five or six varieties of plantains, the island produces bread-fruit; which, however, seems to be scarce. There are also a few cocoa palms; some yams; the kappe of the Friendly islands, or Virginian arum; the etooa tree, and odoriferous gardenia, or cape

cape jasmine. Our people also met with several trees of the dooe dooe, that bear the oily nuts, which are stuck upon a kind of skewer and made use of as candles. There is a species of sida, or Indian mallow; also the morinda citrifolia, which is here called *none;* a species of convolvulus; the ava or intoxicating pepper, besides great quantities of gourds. These last grow to a very large size, and are of a remarkable variety of shapes, which are perhaps the effect of art.

The scarlet birds, which were brought for sale, were never met with alive; but one small one was seen, about the size of a canary bird, of a deep crimson colour; also a large owl, two brown hawks or kites, and a wild duck. Other birds were mentioned by the natives; among which were the otoo, or bluish heron, and the torata, a sort of whimbrel. It is probable that the species of birds are numerous, if we may judge by the quantity of fine yellow, green, and small velvet-like blackish feathers used upon the cloaks and other ornaments worn by these people. Fish, and other productions of the sea, were, to appearance, not various. The only tame or domestic animals found here were hogs, dogs, and fowls, which were all of the same kind that had been met with at the islands of the South Pacific. There were also small lizards, and some rats.

The inhabitants of Atooi are of the middle size, and in general stoutly made. They are neither remarkable for a beautiful shape nor for striking features. Their visage, particularly that of the women, is sometimes round, but others have it long; nor can it justly be said, that they are distinguished as a nation by any general cast of countenance. Their complexion is nearly of a nut-brown; but some individuals are of a darker hue. They are far from being ugly, and have, to all appearance, few natural deformities of any kind. Their skin is not very soft nor shining; but their eyes and teeth are, for the most part, pretty good. Their hair in general is straight; and though its natural colour is usually black, they stain it, as at the Friendly and other islands. They are active, vigorous, and most expert swimmers; leaving their canoes upon the most frivolous occasion, diving under them, and swimming to others, though at a considerable distance. Women with infants at the breast, when the surf was so high as to prevent their landing in the canoes, frequently leaped overboard, and swam to the shore, frequently endangering their little ones. They appeared to be of a frank, cheerful disposition; and are equally free from the fickle levity which characterizes the inhabitants of Otaheite, and the sedate cast which is observable among many of those of Tongataboo. They seem to cultivate a sociable intercourse with each other; and, except the propensity to thieving, which is as it were innate in most of the people in those seas, they appeared extremely friendly. It was pleasing to observe with what affection the women managed their infants, and with what alacrity the men contributed their assistance in such a tender office; thus distinguishing themselves from those savages who consider a wife and child as things rather necessary than desirable or worthy of their regard and esteem. From the numbers that were seen assembled at every village in coasting along, it was conjectured that the inhabitants of this island are pretty numerous. Including the straggling houses, it was computed there might perhaps be, in the whole island, sixty such villages as that near which our ships anchored; and allowing five persons to each house, there would be in every village five hundred, or thirty thousand upon the island. This number is by no means exaggerated; for there were sometimes three thousand people at least collected upon the beach, when it could not be supposed that above a tenth part of the natives were present.

ATRA BILIS, BLACK BILE, OR MELANCHOLY. According to the ancients it hath a twofold origin: 1st, From the grosser parts of the blood, and this they called the *melancholy humour*. 2d, From yellow bile being highly concocted. Dr Percival, in his Essays Med. and Exp. suggests, that it is the gall rendered acrid by a stagnation in the gall-bladder, and rendered viscid by the absorption of its fluid parts. Bile in this state discharged into the duodenum, occasions universal disturbance and disorder until it is evacuated: it occasions violent vomiting, or purging, or both; and previous to this the pulse is quick, the head aches, a delirium comes on, a hiccough, intense thirst, inward heat, and a fetid breath. Some describe this kind of bile as being acid, harsh, corroding, and, when poured on the ground, bubbling up and raising the earth after the manner of a ferment. Dr Percival says, that by the use of the *infus. senæ limon* warmed with the *tinct. columb.* he had checked the vomitings occasioned by this matter.

ATRA DIES, in *Antiquity*, denotes *a fatal day* whereon the Romans received some memorable defeat. The word literally imports *a black day;* a denomination taken from the colour; which is the emblem of death and mourning. Whence the Thracians had a custom of marking all their happy days with white stones or calculi, and their unhappy days with black ones; which they cast, at the close of each day, into an urn. At the person's death the stones were taken out; and from a comparison of the numbers of each complexion, a judgment was made of the felicity or infelicity of his course of life. The *dies atræ* or *atri* were afterwards denominated *nefasti* and *posteri*. Such in particular was the day when the tribunes were defeated by the Gauls at the river Allia, and lost the city; also that whereon the battle of Cannæ was fought; and several others marked in the Roman calendar, as *atræ* or unfortunate.

ATRACTYLIS, DISTAFF THISTLE. See BOTANY *Index*.

ATRÆTI, in *Medicine*, infants having no perforation in the anus, or persons imperforated in the vagina or urethra.

ATRAGENE. See BOTANY *Index*.

ATRAPHAXIS. See BOTANY *Index*.

ATREBATII, a people of Britain, seated next to the Bibroci, in part of Berkshire and part of Oxfordshire. This was one of those Belgic colonies which had come out of Gaul into Britain, and there retained their ancient name. For the Atrebatii were a tribe of the Belgæ, who inhabited the country which is now called Artois. They are mentioned by Cæsar among the nations which composed the Belgic confederacy against him: and the quota of troops which they engaged to furnish on that occasion was 15,000. Comius of Arras was a king or chieftain among the Atrebatii in Gaul in Cæsar's time: and he seems to

have

have poſſeſſed ſome authority, or at leaſt ſome influence, over our Atrebatii in Britain; for he was ſent by Cæſar to perſuade them to ſubmiſſion. This circumſtance makes it probable that this colony of the Atrebatii had not been ſettled in Britain very long before that time. The Atrebatii were among thoſe Britiſh tribes which ſubmitted to Cæſar; nor do we hear of any remarkable reſiſtance they made againſt the Romans at their next invaſion under Claudius. It is indeed probable, that before the time of this ſecond invaſion they had been ſubdued by ſome of the neighbouring ſtates, perhaps by the powerful nation of the Cattivellauni, which may be the reaſon they are ſo little mentioned in hiſtory. Calliva Atrebatum, mentioned in the ſeventh, twelfth, thirteenth, and fourteenth Itinera of Antoninus, and called by Ptolemy *Calcua*, ſeems to have been the capital of the Atrebatii; though our antiquaries differ in their ſentiments about the ſituation of this ancient city, ſome of them placing it at Wallingford, and others at Ilcheſter.

ATREUS, in *Fabulous Hiſtory*, the ſon of Pelops and Hippodamia, and the father of Agamemnon and Menelaus, is ſuppoſed to have been king of Mycenæ and Argos about 1228 years before the Chriſtian era. He drove his brother Thyeſtes from court, for having a criminal commerce with Ærope his wife: but underſtanding that he had had two children by her, he ſent for him again, and made him eat them; at which horrid action, the ſun, it is ſaid, withdrew his light.

ATRI, a town of Italy, in the farther Abruzzo, in the kingdom of Naples, with the title of a duchy; it is the ſee of a biſhop, and is ſeated on a craggy mountain, four miles from the Adriatic ſea. E. Long. 13. 8. N. Lat. 42. 45.

ATRIENSES, in *Antiquity*, a kind of ſervants or officers in the great families at Rome, who had the care and inſpection of the atriæ and the things lodged therein.

Theſe are otherwiſe called atriarii, though ſome make a diſtinction between *atrienſes* and *atriarii;* ſuggeſting that the latter were an inferior order of ſervants, perhaps aſſiſtants of the atrienſes, and employed in the more ſervile offices of the atrium, as to attend at the door, ſweep the area, &c.

The atrienſes are repreſented as ſervants of authority and command over the reſt: they acted as procurators, or agents, of their maſter, in ſelling his goods, &c. To their care were committed the ſtatues and images of the maſter's anceſtors, &c. which were placed round the atrium; and which they carried in proceſſion at funerals, &c.

In the villas, or country-houſes, the atrienſes had the care of the other furniture and utenſils, particularly thoſe of metal, which they were to keep bright from ruſt. Other things they were to hang from time to time in the ſun, to keep them dry, &c. They were clothed in a ſhort white linen habit, to diſtinguiſh them, and prevent their loitering from home.

ATRIP, in *Nautical Language*, is applied either to the anchor or ſails. The anchor is atrip, when it is drawn out of the ground in a perpendicular direction, either by the cable or buoy-rope. The topſails are atrip, when they are hoiſted up to the maſt-head, or to their utmoſt extent.

ATRIPLEX, ORACH, or ARACH. See BOTANY *Index*.

ATRIUM, in *Eccleſiaſtical Antiquity*, denotes an open place or court before a church, making part of what was called the *northex* or *antetemple*.

The atrium in the ancient churches was a large area or ſquare plat of ground, ſurrounded with a portico or cloyſter, ſituated between the porch or veſtibule of the church and the body of the church.

Some have miſtakenly confounded the atrium with the porch or veſtibule, from which it was diſtinct; others with the narthex, of which it was only a part.

The atrium was the manſion of thoſe who were not ſuffered to enter farther into the church. More particularly, it was the place where the firſt claſs of penitents ſtood to beg the prayers of the faithful as they went into the church.

ATRIUM is alſo uſed in the canon-law, for the cemetry or churchyard. In this ſenſe we find a law prohibiting buildings to be raiſed *in atrio eccleſiæ*, except for the clergy: which the gloſſary explains thus, *id eſt in cemeterio*, which includes the ſpace of forty paces around a large church, or thirty round a little church or chapel.

ATROPA, DEADLY NIGHTSHADE. See BOTANY *Index*.

Buchanan gives an account of the deſtruction of the army of Sweno the Dane, when he invaded Scotland, by mixing a quantity of the belladonna berries with the drink which the Scots were, according to a treaty of truce, to ſupply them with. This ſo intoxicated the Danes, that the Scots fell upon them in their ſleep, and killed the greateſt part of them, ſo that there were ſcarcely men enough left to carry off their king. There have alſo been many inſtances in Britain of children being killed by eating berries of a fine black colour, and about the ſize of a ſmall cherry, which are no other than thoſe of belladonna. When an accident of this kind is diſcovered in time, a glaſs of warm vinegar will prevent the bad effects.

Naturaliſts tell ſtrange ſtories of this plant: but ſetting aſide its ſoporiferous virtue, the modern botaniſts will ſcarce warrant any of them, nor even that human figure ordinarily aſcribed to its roots, eſpecially ſince the diſcovery of the artifice of charletans in faſhioning it, to ſurpriſe the credulity of the people.

Moſes informs us (Gen. xxx. 14.) that Reuben the ſon of Leah, being in the field, happened to find mandrakes, which he brought home to his mother. Rachel had a mind to them, and obtained them from Leah, upon condition that ſhe ſhould conſent that Jacob ſhould be Leah's bedfellow the night following. The term דודאים *dudaim*, here made uſe of by Moſes, is one of thoſe words of which the Jews at this day do not underſtand the true ſignification. Some tranſlate it *violets*, others *lilies*, or *jeſſamine*. Junius calls it *agreeable flowers;* Codurquus makes it *truffle*, or *muſhroom;* and Calmet will have it to be the *citron*. Thoſe that would ſupport the tranſlation of *mandrakes* plead, that Rachel being barren, and having a great deſire to conceive, coveted Leah's mandrakes, it may be preſumed, with a view to its prolific virtues. The ancients have given to mandrakes the name of the

apples

apples of love, and to Venus the name of *Mandragoritis*; and the emperor Julian, in his epiſtle to Calixenes, ſays, that he drinks the juice of mandrakes to excite amorous inclinations.

ATROPHY, in *Medicine*, a diſeaſe, wherein the body or ſome of its parts, does not receive the neceſſary nutriment, but waſtes and decays inceſſantly. See Medicine *Index*.

ATROPOS, in *Fabulous Hiſtory*, the name of the third of the Parcæ, or Fates, whoſe buſineſs it was to cut the thread of life.

ATTACHMENT, in the *Law of England*, implies the taking or apprehending a perſon by virtue of a writ or precept. It is diſtinguiſhed from an *arreſt*, by proceeding out of a higher court by precept or writ; whereas the latter proceeds out of an inferior court by precept only. An arreſt lies only on the body of a man; whereas an attachment lies often on the goods only, and ſometimes on the body and goods. An attachment by writ differs from *diſtreſs*, in not extending to lands, as the latter does; nor does a diſtreſs touch the body, as an attachment does.

Attachment out of the Chancery, is obtained upon an affidavit made, that the defendant was ſerved with a ſubpœna, and made no appearance; or it iſſues upon not performing ſome order or decree. Upon the return of this attachment by the ſheriff, *quod non eſt inventus in balliva ſua*, another attachment, with a proclamation, iſſues; and if he ſtill refuſes to appear, a commiſſion of rebellion.

Attachment of the Foreſt, is one of the three courts held in the foreſt. The loweſt court is called the *court of attachment*, or *wood-mote court*; the mean, *ſwanmote*; and the higheſt, the *juſtice in eyre's ſeat*. The court of attachments has its name from the verdurers of the foreſt having no other authority in it, but to receive the attachments of offenders againſt vert and veniſon taken by the foreſters, and to enroll them, that they may be preſented or puniſhed at the next juſtice in eyre's ſeat. This attachment is by three means: by goods and chattels; by body, pledges, or mainprize; or by the body only. This court is held every 40 days throughout the year; and is thence called *forty days court*.

Foreign Attachment, is an attachment of money or goods found within a liberty or city, to ſatisfy ſome creditor within ſuch liberty or city. By the cuſtom of London, and ſeveral other places, a man can attach money or goods in the hands of a ſtranger, to ſatisfy himſelf.

ATTACK, a violent attempt upon any perſon or thing, an aſſault, or the act of beginning a combat or diſpute.

Attack, in the *Military Art*, is an effort made to force a poſt, break a body of troops, &c.

Attack of a Siege, is a furious aſſault made by the beſiegers with trenches, covers, mines, &c. in order to make themſelves maſters of a fortreſs, by ſtorming one of its ſides. If there are two or three attacks made at the ſame time, there ſhould be a communication betwixt them. See War.

ATTACOTTI, an ancient people of Britain, mentioned by Ammianus Marcellinus and St Jerome, as well as in the *Notitia Imperii*. They are repreſented as allies and confederates of the Scots and Picts, and therefore probably their neighbours: though their preciſe ſituation has not been determined by antiquaries.

ATTAINDER, in *Law*. When ſentence of death, the moſt terrible and higheſt judgment in our laws, is pronounced, the immediate inſeparable conſequence by the common law is attainder. For when it is now clear beyond all diſpute, that the criminal is no longer fit to live upon the earth, but is to be exterminated as a monſter and a bane to human ſociety, the law ſets a note of infamy upon him, puts him out of its protection, and takes no farther care of him than barely to ſee him executed. He is then called *attaint*, *attinctus*, *ſtained* or *blackened*. He is no longer of any credit or reputation; he cannot be a witneſs in any court; neither is he capable of performing the functions of another man: for, by an anticipation of his puniſhment, he is already dead in law. This is after judgment; for there is great difference between a man *convicted* and *attainted*; though they are frequently through inaccuracy confounded together. After conviction only, a man is liable to none of theſe diſabilities: for there is ſtill in contemplation of law a poſſibility of his innocence. Something may be offered in arreſt of judgment: the indictment may be erroneous, which will render his guilt uncertain, and thereupon the preſent conviction may be quaſhed: he may obtain a pardon, or be allowed the benefit of clergy; both which ſuppoſe ſome latent ſparks of merit, which plead in extenuation of his fault. But when judgment is once pronounced, both law and fact conſpire to prove him completely guilty; and there is not the remoteſt poſſibility left of any thing to be ſaid in his favour. Upon judgment, therefore, of death, and not before, the attainder of a criminal commences: or upon ſuch circumſtances as are equivalent to judgment of death; as judgment of outlawry on a capital crime, pronounced for abſconding or fleeing from juſtice, which tacitly confeſſes the guilt: and therefore, upon judgment either of outlawry, or of death, for treaſon or felony, a man ſhall be ſaid to be attainted.

A perſon attainted of high treaſon forfeits all his lands, tenements, and hereditaments; his blood is corrupted, and he and his poſterity rendered baſe; and this corruption of blood cannot be taken off but by act of parliament *.

* See the articles *Forfeiture* and *Corruption of Blood*.

Attainders may be reverſed or falſified (i. e. proved to be falſe) by writ of error, or by plea. If by writ of error, it muſt be by the king's leave, &c.; and when by plea, it may be by denying the treaſon, pleading a pardon by act of parliament, &c.

Perſons may be attainted by act of parliament.—Acts of attainder of criminals have been paſſed in ſeveral reigns, on the diſcovery of plots and rebellions, from the reign of King Charles II. when an act was made for the attainder of ſeveral perſons guilty of the murder of King Charles I. Among acts of this nature, that for attainting Sir John Fenwick, for conſpiring againſt King William, is the moſt remarkable; it being made to attaint and convict him of high treaſon on the oath of one witneſs, juſt after a law had been enacted, "That no perſon ſhould be tried or attainted of high treaſon where corruption of blood is incurred, but by the oath of two lawful witneſſes, unleſs the party confeſs, ſtand mute, &c." Stat. 7 and 8. W. III.

W. III. cap. 3. But in the case of Sir John Fenwick there was something extraordinary; for he was indicted of treason on the oaths of two witnesses, though but only one could be produced against him on his trial.

ATTAINT, is a writ that lies after judgment against a jury of twelve men that have given false verdict in any court of record, in an action real or personal, where the debt or damages amounted to above 40s. Stat. 5 and 34 Edw. III. c. 7. It is called *attaint*, because the party that obtains it endeavours thereby to stain or taint the credit of the jury with perjury, by whose verdict he is grieved.

The jury who are to try this false verdict must be twenty-four, and are called *the grand-jury;* for the law wills not that the oath of one jury of twelve men should be attainted or set aside by an equal number, nor by less indeed than double the former. And he that brings the attaint can give no other evidence to the grand jury, than what was originally given to the petit. For as their verdict is now trying, and the question is whether or no they did right upon the evidence that appeared to them, the law adjudged it the highest absurdity to produce any subsequent proof upon such trial, and to condemn the prior jurisdiction for not believing evidence which they never knew. But those against whom it is brought are allowed, in the affirmance of the first verdict, to produce new matter: because the petit jury may have formed their verdict upon evidence of their own knowledge, which never appeared in court; and because very terrible was the judgment which the common law inflicted upon them, if the grand jury found their verdict a false one. The judgment was, 1. That they should lose their *liberam legem*, and become for ever infamous. 2. That they should forfeit all their goods and chattels. 3. That their lands and tenements should be seized into the king's hands. 4. That their wives and children should be thrown out of doors. 5. That their houses should be rased and thrown down. 6. That their trees should be rooted up. 7. That their meadows should be ploughed. 8. That their bodies should be cast into jail. 9. That the party should be restored to all that he lost by reason of the unjust verdict. But as the severity of this punishment had its usual effect, in preventing the law from being executed, therefore by the statute 11 Hen. VII. c. 24. revived by 23 Hen. VIII. c. 3. and made perpetual by 13 Eliz. c. 25. it is allowed to be brought after the death of the party, and a more moderate punishment was inflicted upon attainted jurors: viz. perpetual infamy, and if the cause of action were above 40l. value, a forfeiture of 20l. a-piece by the jurors; or, if under 40l. then 5l. a-piece; to be divided between the king and the party injured. So that a man may now bring an attaint either upon the statute or at common law, at his election; and in both of them may reverse the former judgment. But the practice of setting aside verdicts upon motion, and granting new trials, has so superseded the use of both sorts of attaints, that there is hardly any instance of an attaint later than the 16th century.

ATTAINT, among *Farriers*, a knock or hurt in a horse's leg, proceeding either from a blow with another horse's foot, or from an over-reach in frosty weather, when a horse, being rough shod, or having shoes with long caulkers, strikes his hinder feet against his fore leg.

ATTAINTED, in *Law*, is applied to a person's being under attainder. See ATTAINDER.

ATTALICÆ VESTES, in *Antiquity*, garments made of a kind of cloth of gold. They took the denomination from Attalus, surnamed Philometer, a wealthy king of Pergamus, who was the first, according to Pliny, who procured gold to be wove into cloth.

ATTALUS, the name of several kings of Pergamus. See PERGAMUS.

ATTELABUS. See ENTOMOLOGY *Index*.

ATTENTION, a due application of the ear, or the mind, to any thing said or done, in order to acquire a knowledge thereof. The word is compounded of *ad*, "to," and *tendo*, "I stretch."

Attention of mind is not properly an act of the understanding; but rather of the will, by which it calls the understanding from the consideration of other objects, and directs it to the thing in hand. Nevertheless, our attention is not always voluntary: an interesting object seizes and fixes it beyond the power of controul.

Attention, in respect of hearing, is the stretching or straining of the *membrana tympani*, so as to make it more susceptible of sounds, and better prepared to catch even a feeble agitation of the air. Or it is the adjusting the tension of that membrane to the degree of loudness or lowness of the sound to which we are attentive.

According to the degree of attention, objects make a stronger or weaker impression (A). Attention is requisite even to the simple act of seeing: the eye can take in a considerable field at one look; but no object in the field is seen distinctly but that singly which fixes the attention: in a profound reverie that totally occupies the attention, we scarce see what is directly before us. In a train of perceptions, no particular object makes such a figure as it would do singly and apart; for when the attention is divided among many objects, no particular object is entitled to a large share. Hence the stillness of night contributes to terror, there being nothing to divert the attention:

Horror ubique animos, simul ipsa silentia terrent. Æn. ii.

Zara. Silence and solitude are ev'rywhere!
Through all the gloomy ways and iron doors
That hither lead, nor human face nor voice
Is

(A) Bacon, in his natural history, makes the following observations. "Sounds are meliorated by the intension of the sense, where the common sense is collected most to the particular sense of hearing, and the sight suspended. Therefore sounds are sweeter, as well as greater, in the night than in the day; and I suppose they are sweeter to blind men than to others; and it is manifest, that between sleeping and waking, when all the senses are bound and suspended, music is far sweeter than when one is fully waking."

Is ſeen or heard. A dreadful din was wont
To grate the ſenſe, when enter'd here, from groans
And howls of ſlaves condemn'd, from clink of chains,
And craſh of ruſty bars and creaking hinges;
And ever and anon the ſight was daſh'd
With frightful faces, and the meagre looks
Of grim and ghaſtly executioners.
Yet more this ſtillneſs terrifies my ſoul,
Than did that ſcene of complicated horrors.

Mourning Bride, Act v. ſc. 3.

In matters of ſlight importance, attention is moſtly directed by will; and for that reaſon, it is our own fault if trifling objects make any deep impreſſion. Had we power equally to withhold our attention from matters of importance, we might be proof againſt any deep impreſſion. But our power fails us here: an intereſting object ſeizes and fixes the attention beyond the poſſibility of controul; and while our attention is thus forcibly attached to one object, others may ſolicit for admittance; but in vain, for they will not be regarded. Thus a ſmall misfortune is ſcarcely felt in preſence of a greater:

Lear. Thou think'ſt 'tis much, that this contentious ſtorm
Invades us to the ſkin: ſo 'tis to thee:
But where the greater malady is fix'd,
The leſſer is ſcarce felt. Thoud'ſt ſhun a bear;
But if thy flight lay tow'rd the roaring ſea,
Thou'dſt meet the bear i' th' mouth. When the mind's free,
The body's delicate: the tempeſt in my mind
Doth from my ſenſes take all feeling elſe,
Save what beats there.

King Lear, Act iii. ſc. 5.

ATTENUANTS, or Attenuating *Medicines*, are ſuch as were ſuppoſed to ſubtilize and break the humours into finer parts; and thus diſpoſe them for motion, circulation, excretion, &c.

ATTENUATION, the act of attenuating; that is, of making any fluid thinner, and leſs conſiſtent, than it was before. The word is compounded of *ad* 'to,' and *tenuis* 'thin.' Attenuation is defined more generally by Chavin, the dividing or ſeparating of the minute parts of any body, which before, by their mutual *nexus* or implication, formed a more continuous maſs. Accordingly, among alchemiſts, we ſometimes find the word uſed for pulverization, or the act of reducing a body into an impalpable powder, by grinding, pounding, or the like.

ATTERBURY, Dr Francis, ſon of Dr Lewis Atterbury, was born at Milton in Buckinghamſhire, 1662; educated at Weſtminſter; and from thence elected to Chriſt-church in Oxford, where he ſoon diſtinguiſhed himſelf by his fine genius and turn for polite literature. The year he was made M. A. 1687, he exerted himſelf in the controverſy with the Papiſts, vindicated Luther in the ſtrongeſt manner, and ſhowed an uncommon fund of learning, enlivened with great vivacity. In 1690 he married Miſs Oſborn, a diſtant relation of the duke of Leeds; a lady of great beauty, but with little or no fortune, who lived at or in the neighbourhood of Oxford.

In Feb. 1690-1, we find him reſolved to "beſtir himſelf in his office in the houſe;" that of cenſor probably, an officer (peculiar to Chriſt-church) who preſides over the claſſical exerciſes; he then alſo held the catechetical lecture founded by Dr Buſby.

About this period it muſt have been that he took orders, and entered into another ſcene, and another ſort of converſation; for in 1691 he was elected lecturer of St Bride's church in London, and preacher at Bridewell chapel. An academic life, indeed, muſt have been irkſome and inſipid to a perſon of his active and aſpiring temper. It was hardly poſſible that a clergyman of his fine genius, improved by ſtudy, with a ſpirit to exert his talents, ſhould remain long unnoticed; and we find that he was ſoon appointed chaplain to King William and Queen Mary.

The ſhare he took in the controverſy againſt Bentley (about the genuineneſs of Phalaris's Epiſtles) is now very clearly aſcertained. In one of the letters to his noble pupil, dated "Chelſea 1698 (he ſays), the matter had coſt him ſome time and trouble. In laying the deſign of the book, in writing above half of it, in reviewing a good part of the reſt, in tranſcribing the whole, and attending the preſs (he adds), half a year of my life went away."

In 1700, a ſtill larger field of activity opened, in which Atterbury was engaged four years with Dr Wake (afterwards archbiſhop of Canterbury) and others concerning "the Rights, Powers, and Privileges of Convocations:" in which, however the truth of the queſtion may be ſuppoſed to lie, he diſplayed ſo much learning and ingenuity, as well as zeal for the intereſts of his order, that the lower houſe of convocation returned him their thanks, and the univerſity of Oxford complimented him with the degree of D. D. January 29. 1700, he was inſtalled archdeacon of Totneſs, being promoted to that dignity by Sir Jonathan Trelawney, then biſhop of Exeter. The ſame year he was engaged, with ſome other learned divines, in reviſing an intended edition of the "Greek Teſtament," with Greek "Scholia," collected chiefly from the fathers, by Mr Archdeacon Gregory. At this period he was popular as preacher at the Rolls chapel; an office which had been conferred on him by Sir John Trevor, a great diſcerner of abilities, in 1698, when he reſigned Bridewell, which he had obtained in 1693. Upon the acceſſion of Queen Anne in 1702, Dr Atterbury was appointed one of her Majeſty's chaplains in ordinary; and, in October 1704, was advanced to the deanery of Carliſle. About two years after this, he was engaged in a diſpute with Mr Hoadly, concerning the advantages of virtue with regard to the preſent life; occaſioned by his ſermon, preached Auguſt 30. 1706, at the funeral of Mr Thomas Bennet a bookſeller. In 1707, Sir Jonathan Trelawney, then biſhop of Exeter, appointed him one of the canons reſidentiaries of that church. In 1709, he was engaged in a freſh diſpute with Mr Hoadly, concerning "Paſſive Obedience;" occaſioned by his Latin Sermon, entitled "Concio ad Clerum Londinenſem, habita in Eccleſia S. Elphegi." In 1710, came on the famous trial of Dr Sacheverell, whoſe remarkable ſpeech on that occaſion was generally ſuppoſed to have been drawn up by our author, in conjunction with Dr Smalridge and Dr Freind. The ſame year Dr Atterbury was unanimouſly choſen prolocutor of the lower houſe of convocation, and had the chief management of

Atterbury. of affairs in that house. May 11. 1711, he was appointed by the convocation one of the committee for comparing Mr Whiston's doctrines with those of the church of England; and in June following, he had the chief hand in drawing up "A Representation of the Present State of Religion." In 1712, Dr Atterbury was made dean of Christ-church, notwithstanding the strong interest and warm applications of several great men in behalf of his competitor Dr Smalridge. The next year saw him at the top of his preferment, as well as of his reputation: for, in the beginning of June 1713, the queen, at the recommendation of Lord Chancellor Harcourt, advanced him to the bishopric of Rochester, with the deanery of Westminster in commendam; he was confirmed July 4. and consecrated at Lambeth next day.

At the beginning of the succeeding reign, his tide of prosperity began to turn; and he received a sensible mortification presently after the coronation of King George I. when, upon his offering to present his Majesty (with a view, no doubt, of standing better in his favour) with the chair of state or royal canopy, his own perquisites as dean of Westminster, the offer was rejected, not without some evident marks of dislike to his person.

During the rebellion in Scotland, when the Pretender's declaration was dispersed, the archbishop of Canterbury, and the bishops in or near London, had published a *Declaration of their abhorrence of the present Rebellion, and an Exhortation to the Clergy and People to be zealous in the discharge of their duties to his Majesty King George*: but the bishop of Rochester refused to sign it; and engaged Bishop Smalridge in the same refusal, on account of some reflections it contained against the high church party. He appeared generally among the protestors against the measures of the ministry under the king, and drew up the reasons of the protests with his own hand.

In 1716, we find him advising Dean Swift in the management of a refractory chapter. April 26. 1722, he sustained a severe trial in the loss of his lady; by whom he had four children; Francis, who died an infant; Osborn, student of Christ church; Elizabeth, who died September 29. 1716, aged 17; and Mary, who had been then seven years married to Mr Morice.

In this memorable year, on a suspicion of his being concerned in a plot in favour of the Pretender, he was apprehended August 24. and committed prisoner to the Tower.

Two officers, the under secretary, and a messenger, went about two o'clock in the afternoon to the bishop's house at Westminster, where he then was, with orders to bring him and his papers before the council. He happened to be in his nightgown when they came in; and being made acquainted with their business, he desired time to dress himself. In the mean time his secretary came in; and the officers went to search for his papers; in the sealing of which the messenger brought a paper, which he pretended to have found in his close-stool, and desired it might be sealed up with the rest. His Lordship observing it, and believing it to be a forged one of his own, desired the officers not to do it, and to bear witness that the paper was not found with him. Nevertheless they did it; and though they behaved themselves with some respect to him, they suffered the messengers to treat him in a very rough manner, threatening him, if he did not make haste to dress himself, they would carry him away undrest as he was. Upon which he ordered his secretary to see his papers all sealed up, and went himself directly to the Cock-pit, where the council waited for him. The behaviour of the messengers, upon this occasion, seems to have been very unwarrantable, if what the author of "A Letter to the Clergy of the Church of England," &c. tells us be true, that the persons, directed by order of the king and council to seize his lordship and his papers, received a strict command to treat him with great respect and reverence. However this was, when he came before the council, he behaved with a great deal of calmness, and they with much civility towards him. He had liberty to speak for himself as much as he pleased, and they listened to his defence with a great deal of attention; and, what is more unusual, after he was withdrawn, he had twice liberty to re-enter the council chamber, to make for himself such representations and requests as he thought proper. It is said, that, while he was under examination, he made use of our Saviour's answer to the Jewish council, while he stood before them; "If I tell you, ye will not believe me; and if I also ask you, ye will not answer me, nor let me go." After three quarters of an hour's stay at the Cock-pit, he was sent to the Tower, privately, in his own coach, without any manner of noise or observation.

This commitment of a bishop upon a suspicion of high treason, as it was a thing rarely practised since the Reformation, so it occasioned various speculations among the people. Those who were the bishop's friends, and pretended to the greatest intimacy with him, laid the whole odium of the matter upon the ministry. They knew the bishop so well, they said, his love to the constitution, and attachment to the Protestant succession, his professed abhorrence of Popery, and settled contempt of the Pretender, and his caution, prudence, and circumspection, to be such, as would never allow him to engage in an attempt of subverting the government, so hazardous in itself, and so repugnant to his principles; and therefore they imputed all to the malice and management of a great minister of state or two, who were resolved to remove him, on account of some personal prejudices, as well as the constant molestation he gave them in parliament, and the particular influence and activity he had shown in the late election. The friends to the ministry, on the other hand, were strongly of opinion, that the bishop was secretly a favourer of the Pretender's cause, and had formerly been tampering with things of that nature, even in the queen's time, and while his party was excluded from power; but upon their re-admission, had relinquished that pursuit, and his confederates therein, and became a good subject again. They urged, that the influence which the late duke of Ormond had over him, assisted by his own private ambition and revenge, might prompt him to many things contrary to his declared sentiments, and inconsistent with that cunning and caution which in other cases he was master of. And to obviate the difficulty, arising from the bishop's aversion to Popery, and the Pretender's bigotry to that religion, they talked of a new

Atterbury. new invented ſcheme of his, not to receive the Pretender, whoſe principles were not to be changed, but his ſon only, who was to be educated a Proteſtant in the church of England, and the biſhop to be his guardian, and lord protector of the kingdom, during his minority. Theſe, and many more ſpeculations, amuſed the nation at that time; and men, as uſual, judged of things by the meaſure of their own affections and prejudices.

March 23. 1722-3, a bill was brought into the houſe of commons, for "inflicting certain pains and penalties on Francis Lord Biſhop of Rocheſter;" a copy of which was ſent to him, with notice that he had liberty of counſel and ſolicitors for making his defence. Under theſe circumſtances the biſhop applied, by petition, to the houſe of lords for their direction and advice as to his conduct in this conjuncture; and April 4. he acquainted the ſpeaker of the houſe of commons, by a letter, that he was determined to give that houſe no trouble in relation to the bill depending therein; but ſhould be ready to make his defence againſt it when it ſhould be argued in another houſe, of which he had the honour to be a member. On the 9th the bill paſſed the houſe of commons, and was the ſame day ſent up to the houſe of lords for their concurrence.

May 6th being the day appointed by the lords for the firſt reading of the bill, Biſhop Atterbury was brought to Weſtminſter to make his defence. The counſel for the biſhop were, Sir Conſtantine Phipps and William Wynne, Eſq.; for the king, Mr Reeve and Mr Wearg. The proceedings continued above a week: and on Saturday May 11th, the biſhop was permitted to plead for himſelf. This he did in a very eloquent ſpeech; which he feelingly opens by complaining of the uncommon ſeverity he had experienced in the Tower; which was carried to ſo great a length, that not even his ſon-in-law Mr Morice was permitted to ſpeak to him in any nearer mode than ſtanding in an open area, whilſt the biſhop looked out of a two-pair-of-ſtairs window. In the courſe of his defence he obſerves, "Here is a plot of a year or two ſtanding, to ſubvert the government with an armed force; an invaſion from abroad, an inſurrection at home: juſt when ripe for execution, it is diſcovered; and twelve months after the contrivance of this ſcheme, no conſultation appears, no men correſponding together, no proviſion made, no arms, no officers provided, not a man in arms; and yet the poor biſhop has done all this. What could tempt me to ſtep thus out of my way? Was it ambition, and a deſire of climbing into a higher ſtation in the church? There is not a man in my office farther removed from this than I am. Was money my aim? I always deſpiſed it too much, conſidering what occaſion I am now like to have for it: for out of a poor biſhopric of 500l. per annum, I have laid out no leſs than 1000l. towards the repairs of the church and epiſcopal palace; nor did I take one ſhilling for dilapidations. The reſt of my little income has been ſpent, as is neceſſary, as I am a biſhop. Was I influenced by any diſlike of the eſtabliſhed religion, and ſecretly inclined towards a church of greater pomp and power? I have, my lords, ever ſince I knew what Popery was, oppoſed it; and the better I knew it, the more I oppoſed it. I began my ſtudy in divinity, when the Popiſh controverſy grew hot, with that immortal book of Tillotſon's, when he undertook the Proteſtant cauſe in general; and as ſuch, I eſteemed him above all. You will pardon me, my lords, if I mention one thing: Thirty years ago, I writ in defence of Martin Luther; and have preached, expreſſed, and wrote to that purpoſe from my infancy; and whatever happens to me, I will ſuffer any thing, and, by God's grace, burn at the ſtake, rather than depart from any material point of the Proteſtant religion as profeſſed in the church of England. Once more: Can I be ſuppoſed to favour arbitrary power? The whole tenor of my life has been otherwiſe: I was always a friend to the liberty of the ſubject; and, to the beſt of my power, conſtantly maintained it. I may have been thought miſtaken in the meaſures I took to ſupport it; but it matters not by what party I was called, ſo my actions are uniform." Afterwards, ſpeaking of the method of proceeding againſt him as unconſtitutional, he ſays: "My ruin is not of that moment to any number of men, to make it worth their while to violate, or even to ſeem to violate, the conſtitution in any degree, which they ought to preſerve againſt any attempts whatſoever. Though I am worthy of no regard, though whatſoever is done to me may for that reaſon be looked upon to be juſt; yet your lordſhips will have ſome regard to your own laſting intereſt and that of poſterity. This is a proceeding with which the conſtitution is unacquainted; which, under the pretence of ſupporting it, will at laſt effectually deſtroy it. For God's ſake, lay aſide theſe extraordinary proceedings; ſet not up theſe new and dangerous precedents. I, for my part, will voluntarily and cheerfully go into perpetual baniſhment, and pleaſe myſelf that I am in ſome meaſure the occaſion of putting a ſtop to ſuch precedents, and doing ſome good to my country: I will live, wherever I am, praying for its proſperity; and do, in the words of Father Paul to the ſtate of Venice, ſay, *Eſto perpetua.* It is not my departing from it I am concerned for. Let me depart, and let my country be fixed upon the immoveable foundation of law and juſtice, and ſtand for ever." After a ſolemn proteſtation of his innocence, and an appeal to the Searcher of Hearts for the truth of what he had ſaid, he concludes thus: "If, on any account, there ſhall ſtill be thought by your lordſhips to be any ſeeming ſtrength in the proofs againſt me; if, by your lordſhips judgments, ſpringing from unknown motives, I ſhall be thought to be guilty; if, for any reaſons or neceſſity of ſtate, of the wiſdom and juſtice of which I am no competent judge, your lordſhips ſhall proceed to paſs this bill againſt me; I ſhall diſpoſe myſelf quietly and tacitly to ſubmit to what you do; God's will be done: Naked came I out of my mother's womb, and naked ſhall I return; and, whether he gives or takes away, bleſſed be the name of the Lord!"

On Monday the 13th he was carried for the laſt time from the Tower to hear the reply of the king's counſel to his defence. Theſe were both men of great knowledge and ſagacity in law, but of different talents in point of eloquence. Their ſpeeches on this occaſion were made public; and they ſeem to have formed their "Replies," deſignedly, in a different way. The former ſticks cloſe to the matter in evidence, and enforces the charge againſt the biſhop with great ſtrength

and

and perſpicuity: The latter anſwers all his objections, and refutes the arguments brought in his defence, in an eaſy ſoft manner, and with great ſimplicity of reaſoning. Mr Reeve is wholly employed in facts, in comparing and uniting together circumſtances, in order to corroborate the proofs of the biſhop's guilt: Mr Wearg is chiefly taken up in ſilencing the complaints of the biſhop and his counſel, and replying to every thing they advance, in order to invalidate the allegations of his innocence. The one, in ſhort, poſſeſſes the minds of the lords with ſtrong convictions againſt the biſhop: The other diſpoſſeſſes them of any favourable impreſſion that might poſſibly be made upon them by the artifice of his defence. And accordingly Mr Reeve is ſtrong, nervous, and enforcing; but Mr Wearg, ſmooth, eaſy, and inſinuating, both in the manner of his expreſſion and the turn of his periods. Mr Wearg pays the higheſt compliments to the biſhop's eloquence: but, at the ſame time, repreſents it as employed to impoſe upon the reaſon, and miſguide the judgment of his hearers in proportion as it affected their paſſions; and he endeavours to ſtrip the biſhop's defence of all its ornaments and colour of rhetoric.

On the 15th the bill was read the third time; and, after a long and warm debate, paſſed on the 16th, by a majority of 83 to 43. On the 27th, the king came to the houſe, and confirmed it by his royal aſſent. June 18. 1723, this eminent prelate, having the day before taken leave of his friends, who, from the time of paſſing the bill againſt him to the day of his departure, had free acceſs to him in the Tower (B), embarked on board the Aldborough man of war, and landed

(B) The following anecdote was firſt communicated to the public by the late Dr Maty, on the credit of Lord Cheſterfield: "I went (ſaid Lord Cheſterfield) to Mr Pope, one morning, at Twickenham, and found a large folio bible, with gilt claſps, lying before him upon his table; and, as I knew his way of thinking upon that book, I aſked him, jocoſely, if he was going to write an anſwer to it? It is a preſent, ſaid he, or rather a legacy, from my old friend the Biſhop of Rocheſter. I went to take my leave of him yeſterday in the Tower, where I ſaw this bible upon his table. After the firſt compliments, the Biſhop ſaid to me. 'My friend Pope, conſidering your infirmities, and my age and exile, it is not likely that we ſhould ever meet again; and therefore I give you this legacy to remember me by it. Take it home with you; and let me adviſe you to abide by it.'—'Does your Lordſhip abide by it yourſelf?'—'I do. 'If you do, my Lord, it is but lately. May I beg to know what new light or arguments have prevailed with you now, to entertain a opinion ſo contrary to that which you entertained of that book all the former part of your life?'—The Biſhop replied, 'We have not time to talk of theſe things; but take home the book; I will abide by it, and I recommend you to do ſo too; and ſo God bleſs you.'

Theſe anecdotes Mr Nichols has inſerted in the "Epiſtolary Correſpondence," vol. ii. p. 79. with the profeſſed view of vindicating Atterbury, in the following words of an ingenious corrreſpondent:

"Dr Warton has revived this ſtory, which he juſtly calls an 'uncommon' one, in his laſt 'Eſſay on the Genius and Writings of Pope.' It was indeed very uncommon; and I have my reaſons for thinking it equally groundleſs and invidious. Dr Warton, though he retails the ſtory from 'Maty's Memoirs,' yet candidly acknowledges, that it ought not to be implicitly relied on. That this caution was not unneceſſary, will, I apprehend, be ſufficiently obvious, from the following compariſon between the date of the ſtory itſelf and Mr Pope's letters to the biſhop.

"According to Lord Cheſterfield's account, this remarkable piece of converſation took place but a few days before the Biſhop went into exile: and it is inſinuated that Mr Pope, till that period, had not even entertained the ſlighteſt ſuſpicion of his friend's reverence for the bible: Nay, it is aſſerted, that the very recommendation of it from a quarter ſo unexpected, ſtaggered Mr Pope to ſuch a degree, that in a mingled vein of raillery and ſeriouſneſs, he was very eager to know the grounds and reaſons of the Biſhop's change of ſentiment.

"Unfortunately for the credit of Lord Cheſterfield and his ſtory, there is a letter on record, that was written nine months before this pretended dialogue took place, in which Mr Pope ſeriouſly acknowledged the Biſhop's piety and generoſity, in intereſting himſelf ſo zealouſly and affectionately in matters which immediately related to his improvement in the knowledge of the holy ſcriptures. The paſſage I refer to is a very remarkable one: and you will find it in a letter, dated July 27. 1722. It appears undeniably from this letter, that the Biſhop had earneſtly recommended to Mr Pope the ſtudy of the bible; and had ſoftened his zeal with an unuſual urbanity and courteſy, in order to avoid the imputation of ill-breeding, and remove all occaſion of diſguſt from a mind ſo 'tremblingly alive' as Mr Pope's. I will tranſcribe the paſſage at large. 'I ought firſt to prepare my mind for a better knowledge even of good profane writers, eſpecially the moraliſts, &c. before I can be worthy of taſting the Supreme of books, and Sublime of all writings, in which, as in all the intermediate ones, you may (if your friendſhip and charity towards me continue ſo far) be the beſt guide to, Yours, A. Pope.'

"The laſt letter of Mr Pope to the Biſhop, previous to his going into exile, was written very early in June 1723. It muſt have been about this time that Pope paid his farewell viſit to the Biſhop in the Tower. But whether ſuch a converſation as that which hath been pretended actually took place, may be left to the determination of every man of common ſenſe, after comparing Lord Cheſterfield's anecdote with Mr Pope's letter.

"There muſt have been a miſtake, or a wilful miſrepreſentation ſomewhere. To determine its origin, or to mark minutely the various degrees of its progreſs, till it iſſued forth into calumny and falſehood, is impoſſible.

Atterbury. landed the Friday following at Calais. When he went on ſhore, having been informed that Lord Bolingbroke, who had, after the riſing of the parliament, received the king's pardon, was arrived at the ſame place on his return to England, he ſaid, with an air of pleaſantry. "Then I am exchanged!" and it was, in the opinion of Mr Pope on the ſame occaſion, "a ſign of the nation's being curſedly afraid of being overrun with too much politeneſs, when it could not regain one great man but at the expence of another." But the ſeverity of his treatment did not ceaſe even with his baniſhment. The ſame vindictive ſpirit purſued him in foreign climes. No Britiſh ſubject was even permitted to viſit him without the king's ſign manual, which Mr Morice was always obliged to ſolicit, not only for himſelf, but for every one of his family whom he carried abroad with him, for which the fees of office were very high.

When Biſhop Atterbury firſt entered upon his baniſhment, Bruſſels was the place deſtined for his reſidence; but, by the arts and inſtigations of the Britiſh miniſters, he was compelled to leave that place, and retire to Paris. There being ſolicited by the friends of the Pretender to enter into their negociations, he changed his abode for Montpelier in 1728; and, after reſiding there about two years, returned to Paris, where he died Feb. 15. 1731-2. The affliction which he ſuſtained by the death of his daughter in 1729, was thought to have haſtened his own diſſolution. The former event he hath himſelf related in a very affecting manner, in a letter to Mr Pope: "The earneſt deſire of meeting one I dearly loved, called me abruptly to Montpelier; where, after continuing two months under the cruel torture of a ſad and fruitleſs expectation, I was forced at laſt to take a long journey to Toulouſe; and even there I had miſſed the perſon I ſought, had ſhe not, with great ſpirit and courage, ventured all night up the Garronne to ſee me, which ſhe above all things deſired to do before ſhe died. By that means ſhe was brought where I was, between ſeven and eight in the morning, and lived 20 hours afterwards; which time was not loſt on either ſide, but paſſed in ſuch a manner as gave great ſatisfaction to both, and ſuch as, on her part, every way became her circumſtances and character: For ſhe had her ſenſes to the very laſt gaſp, and exerted them to give me, in thoſe few hours, greater marks of duty and love than ſhe had done in all her lifetime, though ſhe had never been wanting in either. The laſt words ſhe ſaid to me were the kindeſt of all; a reflection on the goodneſs of God, which had allowed us in this manner to meet once more, before we parted for ever. Not many minutes after that, ſhe laid herſelf on her pillow, in a ſleeping poſture,

Placidaque ibi demum morte quievit.

Judge you, Sir, what I felt, and ſtill feel, on this occaſion, and ſpare me the trouble of deſcribing it. At my age, under my infirmities, among utter ſtrangers, how ſhall I find out proper reliefs and ſupports? I can have none, but thoſe with which reaſon and religion furniſh me; and thoſe I laid hold on, and graſp as faſt as I can. I hope that He who laid the burden upon me (for wiſe and good purpoſes no doubt) will enable me to bear it in like manner as I have borne others, with ſome degree of fortitude and firmneſs."

How far the biſhop might have been attached in his inclinations to the Stuart family, to which he might be led by early prejudices of education, and the divided opinions of the times, it is not neceſſary here to inquire: But that he ſhould have been weak enough to engage in a plot ſo inconſiſtent with his ſtation, and ſo clumſily deviſed (to ſay the leaſt of it, and without entering into his ſolemn aſſeveration of innocence,) is utterly inconſiſtent with that cunning which his enemies allowed him. The duke of Wharton, it is well known, was violent againſt him, till convinced by his unanſwerable reaſoning.

It has been ſaid that Atterbury's wiſhes reached to the biſhopric of London, or even to York or Canterbury. But thoſe who were better acquainted with his views, knew that Wincheſter would have been much more deſirable to him than either of the others. And there are thoſe now living, who have been told from reſpectable authority, that that biſhopric was offered to him whenever it ſhould become vacant (and till that event ſhould happen, a penſion of 5000l. a-year, beſides an ample proviſion for Mr Morice), if he would ceaſe to give the oppoſition he did to Sir Robert Walpole's adminiſtration, by his ſpeeches and proteſts in the houſe of lords. When that offer was rejected by the biſhop, then the contrivance for his ruin was determined on.

In his ſpeech in the houſe of lords, the biſhop mentions his being "engaged in a correſpondence with two learned men (Biſhop Potter and Dr Wall) on ſettling the times of writing the four goſpels." Part of this correſpondence is ſtill in being, and will ſoon be publiſhed. The ſame ſubject the biſhop purſued during his exile, having conſulted the learned of all nations, and had nearly brought the whole to a concluſion when he died. Theſe laudable labours are an ample confutation of Biſhop Newton's aſſertion, that Atterbury "wrote little whilſt in exile but a few criticiſms on French authors."

His body was brought over to England, and interred on the 12th of May following in Weſtminſter abbey, in a vault which in the year 1722 had been prepared by his directions. There is no memorial over his grave; nor could there well be any, unleſs his friends would have conſented (which it is moſt probable they refuſed to do) that the words implying him to have died biſhop of Rocheſter ſhould have been omitted on his tomb.

Some

I have ſimply ſtated matters of fact as they are recorded; and leave it to your readers to ſettle other points not quite ſo obvious and indiſputable, as they may think fit. My motives in this very plain relation aroſe from an honeſt wiſh to remove unmerited obloquy from the dead. I ſhould ſincerely rejoice if the cloud which in other reſpects ſtill ſhades the character of this ingenious prelate could be removed with equal facility and ſucceſs. I am, dear Sir, your faithful humble ſervant,

SAMUEL BADCOCK."

Atterbury.

Some time before his death, he published a vindication of himself, Bishop Smalridge, and Dr Aldrich, from a charge brought against them by Mr Oldmixon, of having altered and interpolated the copy of Lord Clarendon's "History of the Rebellion." Bishop Atterbury's "Sermons" are extant in four volumes in octavo: those contained in the two first were published by himself, and dedicated to his great patron Sir Jonathan Trelawney bishop of Winchester; those in the two last were published after his death by Dr Thomas Moore his Lordship's chaplain. Four admirable "Visitation Charges" accompany his "Epistolary Correspondence."

As to Bishop Atterbury's character, however the moral and political part of it may have been differently represented by the opposite parties, it is universally agreed, that he was a man of great learning and uncommon abilities, a fine writer, and a most excellent preacher. His learned friend Smalridge, in the speech he made when he presented him to the upper house of convocation, as prolocutor, styles him *Vir in nullo literarum genere hospes, in plerisque artibus et studiis diu et feliciter exercitatus, in maxime perfectis literarum disciplinis perfectissimus.* In his controversial writings, he was sometimes too severe upon his adversary, and dealt rather too much in satire and invective; but this his panegyrist imputes more to the natural fervour of his wit than to any bitterness of temper or prepense malice. In his sermons, however, he is not only every way unexceptionable, but highly to be commended. The truth is, his talent as a preacher was so excellent and remarkable, that it may not improperly be said, that he owed his preferment to the pulpit; nor any hard matter to trace him, through his writings, to his several promotions in the church. We shall conclude Bishop Atterbury's character as a preacher, with the encomium bestowed on him by the author of "the Tatler;" who, having observed that the English clergy too much neglected the art of speaking, makes a particular exception with regard to our prelate; who, says he, "has so particular a regard to his congregation, that he commits to his memory what he has to say to them; and has so soft and graceful a behaviour, that it must attract your attention. His person (continues this author), it is to be confessed, is no small recommendation; but he is to be highly commended for not losing that advantage, and adding to propriety of speech (which might pass the criticism of Longinus) an action which would have been approved by Demosthenes. He has a peculiar force in his way, and has affected many of his audience, who could not be intelligent hearers of his discourse were there no explanation as well as grace in his action. This art of his is used with the most exact and honest skill. He never attempts your passions, till he has convinced your reason. All the objections which you can form are laid open and dispersed before he uses the least vehemence in his sermon; but when he thinks he has your head, he very soon wins your heart, and never pretends to show the beauty of holiness, till he has convinced you of the truth of it."—In his letters to Pope, &c. Bishop Atterbury appears in a pleasing light, both as a writer and as a man. In ease and elegance they are superior to those of Pope, which are more studied. There are in them several beautiful references to the classics. The bishop excelled in his allusions to sacred as well as profane authors.

Attestation || Attica.

ATTESTATION, the act of affirming or witnessing the truth of something, more especially in writing.

ATTIC, any thing relating to Attica, or to the city of Athens: thus Attic salt, in philology, is a delicate poignant sort of wit and humour peculiar to the Athenian writers; Attic witness, a witness incapable of corruption, &c.

Attic Order. See ARCHITECTURE.

Attic Base, a peculiar kind of base used by the ancient architects in the Ionic order; and by Palladio, and some others, in the Doric.

Attic Story, in *Architecture*; a story in the upper part of a house, where the windows are usually square.

ATTICA, an ancient kingdom of Greece, situated along the north coast of the gulf of Saron; bounded on the west by Megara, Mount Cithæron, and part of Bœotia; on the north by the gulf of Euripus, now *Stretto di negro ponte*, and the rest of Bœotia; and on the east by the Euripus. It extends in length from north-west to south-east about 60 miles; its breadth from north to south was 56, decreasing as it approached the sea. 1 Boundaries, extent, &c.

The soil of this country was naturally barren and craggy, though by the industry of its inhabitants it produced all the necessaries of life. On this account Attica was less exposed to invasions than other more fertile countries; and hence it preserved its ancient inhabitants beyond all the other kingdoms in its neighbourhood; so that they were reputed to be the spontaneous productions of the soil; and as a badge of this, Thucydides tells us, they wore golden grasshoppers in their hair. 2 Inhabitants thought to be produced from the soil.

The chief cities in the kingdom of Attica were Athens the capital; next to it Eleusis, situated on the same gulf, near the coast of Megara; and next to that Rhamnus famed for the temple of Amphiaraus and the statue of the goddess Nemesis. 3 Cities.

The first king of this country, of whom we have any distinct account, was Cecrops. Others indeed are said to have reigned before him, particularly one Actæus, whose daughter Cecrops married, and in her right laid the foundation of his new monarchy. Cecrops is said to have been the first who deified Jupiter, set up altars and idols, and instituted marriage among the Greeks. He is likewise affirmed to have taught his subjects navigation; and for the better administration of justice, and promoting intercourse among them, to have divided them into the first four tribes, called *Cecropis*, *Antochthon*, *Actea*, and *Paralia*; and he is also by some said to be the founder of the Areopagus. From this monarch the Athenians affected to call themselves *Cecropidæ* till the reign of Erectheus their sixth king, after whom they took the name of *Erecthydæ*. 4 Cecrops the first king.

Cecrops dying after a reign of 50 years, left three daughters; by marrying one of whom, probably, Cranaus a wealthy citizen ascended the throne. He enjoyed his crown peaceably for ten years; till, having married one of his daughters named *Attis*, to Amphictyon the son of Deucalion, he was by him dethroned, and forced to lead a private life to the last. From this daughter, the country, which before had been called *Actea*, took the name of *Attica*. 5 Cranaus. 6 Whence the country was called Attica.

After

Attica.

After a reign of 10 or 12 years, Amphictyon was himſelf depoſed by Ericthonius, ſaid to be the ſon of 7 Ericthonius. Vulcan and Tethys. Being lame of both his feet, he is ſaid to have invented coaches, or, as others will have 8 Pandion. it, inſtituted horſe and chariot races, in honour of Minerva. He is alſo reported to have been the firſt who ſtamped ſilver coin. He reigned 50 years, and was ſucceeded by his ſon Pandion the father of Progne and Philomela; whoſe hard fate, ſo famous among the poets, is ſuppoſed to have broke his heart, after a reign of about 40 years. In his time Triptolemus taught the Athenians agriculture, which he had learned from Ceres.

9 Erectheus. Pandion was ſucceeded by his ſon Erectheus, who being reckoned the moſt powerful prince of his time, Boreas king of Thrace demanded his daughter Orithia in marriage, and on being refuſed carried her off by force. After a reign of 50 years, Erectheus being 10 killed in a battle with the Eleuſians, was ſucceeded by Cecrops II. his ſon Cecrops II. who is generally allowed to have been the firſt who gathered the people into towns; they having till then lived in houſes and cottages ſcattered here and there, without order or regular diſtance. After a reign of 40 years he was driven out by his brethren Metion and Pandorus, who forced him to fly into Ægialea, where he died.

11 Pandion II. Cecrops II. was ſucceeded by his ſon Pandion II. and he was likewiſe driven out by Metion, who aſſumed the government. Pandion in the mean time fled into Megara, where he married Pelia the daughter of Pylas king of that place, and was appointed ſucceſſor to the kingdom. Here he had four ſons, who returning to Athens, whether with or without their father is uncertain, expelled the ſons of Metion, and after the deceaſe of Pandion their father, divided the government among themſelves; notwithſtanding which, the royal dignity did in effect remain with Ægeus the eldeſt.

12 Ægeus. Ægeus, when he aſcended the throne, finding himſelf deſpiſed by his ſubjects becauſe he had no ſons, and ſometimes inſulted by his brother Pallas, who had no leſs than fifty, conſulted the oracle of Apollo at Delphi. Receiving here, as was commonly the caſe, an anſwer which could not be underſtood without a commentator, he applied to Pittheus king of Troezen, famous for his ſkill in expounding oracles. This prince eaſily prevailed with him to lie with his daughter Æthra, who proved with child; and as none but theſe three were privy to the ſecret, Ægeus, before his return to Athens, hid a ſword and a pair of ſhoes under a ſtone, leaving orders with the princeſs, that if the child proved a boy, ſhe ſhould ſend him to Athens with theſe tokens as ſoon as he was able to lift up that ſtone. He charged her moreover to uſe all imaginable ſecrecy, leſt the ſons of his brother Pallas ſhould way-lay and murder him.

13 Theſeus born. Æthra being delivered of a ſon, Pittheus gave out that Neptune was the father of it. This child was named *Theſeus*, and proved one of the moſt famous heroes of antiquity. Being arrived at the age of 16, his mother brought him to the ſtone above mentioned; and he having lifted it with eaſe, was deſired to take up the ſword and ſhoes and prepare himſelf to go to his father. He was adviſed to go by ſea rather than by land, as, ever ſince the departure of Hercules, the roads had been exceedingly infeſted by banditti. Theſeus, however, who had already begun to diſcover marks of uncommon ſtrength and courage, no ſooner heard the name of Hercules mentioned, than he became deſirous of imitating ſo great a pattern; and after performing a number of glorious exploits, for which ſee the article Theseus, he arrived ſafe at his father's capital.

The great atchievements of our young hero procured him a welcome reception at the court of Ægeus, though his birth was unknown to all except Medea, to whom the king had lately been married. This queen being a ſorcereſs, it is not to be ſuppoſed any thing could be concealed from her: ſhe therefore, by her diabolical penetration, quickly found out that Theſeus was the king's ſon; after which ſhe became ſo jealous of him on account of his valour, that ſhe perſuaded her old huſband to invite the young ſtranger to a banquet, and poiſon him in a glaſs of wine. The poiſon was accordingly prepared, and Theſeus invited; but the prince ſuddenly drawing his ſword, it was immediately recognized by Ægeus to be the ſame he had formerly buried below the ſtone. Upon this he ſtepped forward to Theſeus, throwing down the poiſoned draught in his way; and, embracing him with much tenderneſs, owned him for his ſon before all the court. 14 Is made known to his father.

At this time the king of Athens had great occaſion for ſuch a champion as Theſeus. The ſons of Pallas, who had all along behaved with great inſolence, upon Theſeus being diſcovered to be the king's ſon, and heir apparent to the crown, broke out in open rebellion. They were ſoon diſcomfited; but Ægeus and the whole country of Attica were ſtill in great diſtreſs 15 He kills the Minotaur. on the following account. Some years before, Androgeus, the ſon of Minos king of Crete, came to Athens to be preſent at one of their feaſts. During this viſit he contracted ſuch an intimacy with the fifty ſons of Pallas, that Ægeus, fearing ſome fatal conſequences, cauſed him to be privately murdered. According to others, Androgeus having undertaken to encounter the Marathonian bull, was killed by it. Be this as it will, Minos having received news of his ſon's death, imputed it to the people of Attica; and therefore, after ſeveral unſucceſsful attempts to revenge his own quarrel, prayed to the gods to do it for him. The Athenians, in conſequence of this prayer, were viſited with earthquakes, famine, and peſtilence; on account of which they applied to the oracle. Here they were informed, that no relief was to be had till they were reconciled to the Cretan king. Minos reſolving to make them pay dear for their deliverance, impoſed upon them a tribute of ſeven young men and as many virgins, whom he condemned to be devoured by the Minotaur, a monſter feigned by the poets to have been half man and half bull. This bloody tribute had been twice paid, and Minos had already ſent his meſſengers the third time, when Theſeus willingly offered himſelf to be one of the unhappy victims; and embarking with them in one ſhip, he gave the pilot two ſails, the one black to ſail with, and the other white to be hoiſted up at his return in caſe he came off victorious. Our hero had all the ſucceſs he could wiſh: he killed the Minotaur, prevailed with Minos to remit the tribute, and his daughter Ariadne to run away with him; but her he left with child in the iſle of Naxos. Unfortunately, however for Ægeus, the joy of Theſeus and his

Attica. his company was ſo great, that at their return they
forgot to hoiſt the white flag in token of their victory:
16 Death of Ægeus. upon which the old king, taking for granted that his
ſon was killed, threw himſelf into the ſea, which ever
17 ſince has from him been called the *Ægean Sea*.
Theſeus king of Attica. Theſeus being thus left in poſſeſſion of the kingdom
of Attica, began immediately to think of indulging his
18 warlike genius, and rendering the civil affairs of his
New models the government. kingdom as little troubleſome as poſſible. To accompliſh this purpoſe, he began with gathering moſt of the
people of Attica into the old and new town, which he
incorporated into one city. After this he diveſted
himſelf of all his regal power, except the title of king,
the command of the army, and the guardianſhip of
the laws. The reſt he committed to proper magiſtrates
choſen out of three different orders of the people, whom
he divided into nobles, huſbandmen, and artificers.
The firſt he inveſted with the power of interpreting and
executing the laws, and regulating whatever related to
religion. The other two choſe their inferior magiſtrates
from among themſelves, to take care of whatever related to their ſeparate orders: ſo that the kingdom was
in ſome meaſure reduced to a commonwealth, in which
the king had the greateſt poſt, the nobles were next
to him in honour and authority, the huſbandmen had
the greateſt profit, and the artiſts exceeded them in
number. He likewiſe aboliſhed all their diſtinct courts
of judicature, and built one common council hall called
Prytaneum, which ſtood for many ages afterwards.

Having thus new-modelled the government, his next
care was to join to his dominions the kingdom of Megara, in right of his grandfather Pandion II. who had
married the daughter of Pylas, as above-mentioned. On
this occaſion he erected the famous pillar in the iſthmus,
which ſhowed the limits of the two countries that met
there. On the one ſide of this pillar was inſcribed,
19 "This is not Peloponneſus, but Ionia;" and on the
Defeats the Amazons, kills the Centaurs, and carries off Helena. other, "This is Peloponneſus, not Ionia." After this
he undertook an expedition againſt the Amazons,
whom he overcame, took their queen Hippolita, and
afterwards married her. Soon after this, Theſeus contracted an intimacy with Perithous the ſon of Ixion:
and being invited to his nuptials, aſſiſted him in killing a number of Centaurs, or rather Theſſalian horſemen (who in their cups had offered violence to their
female gueſts), and drove the reſt out of the country.
Our two aſſociates then proceeded to Sparta, where
Theſeus fell in love with the famed Helena, at that
time not above nine years old, while he himſelf was
upwards of fifty. Her they carried off: and of the
rape there are various accounts; but the following one
which is given by Plutarch, is generally allowed to be
the moſt authentic.

According to that hiſtorian, they ſtole this beauty,
the greateſt in the world at that time, out of the temple
of Diana Ortia, where Helena happened to be dancing. They were purſued as far as Tegea, but made
their eſcape out of Peloponneſus; and thinking themſelves now ſecure of their prey, they agreed to caſt lots
for her, upon condition that he to whoſe lot ſhe fell
ſhould aſſiſt the other in procuring ſome celebrated
beauty. Fortune having declared for Theſeus, he aſſiſted his companion in the like attempt upon Proſerpina daughter of Aidonius king of the Molloſſi in
Epirus; who, being the next beauty to Helena, was

I

guarded by the dog Cerberus, which had three heads, Attica.
and was conſequently a very formidable enemy. Her
father, however, underſtanding that they deſigned to
ſteal away his daughter, threw Perithous to be torn in 20
pieces by Cerberus, and put Theſeus in priſon, from Impriſoned by the king of Epirus.
whence he was afterwards relieved at the interceſſion of
Hercules.

After this misfortune, Theſeus at length returned to
Athens, but found himſelf very coolly received by his
ſubjects. Mneſtheus, the ſon of Pteus, and great-grandſon of Erectheus, had made uſe of the king's abſence to ingratiate himſelf with the people; and, upon,
the commencement of a war with Caſtor and Pollux, the
two brothers of Helena, he perſuaded the people of 21
Athens to open their gates to the two brothers. Upon this, Theſeus was under the neceſſity of conveying Driven out of Athens.
away himſelf and family with all poſſible privacy. This
he luckily accompliſhed; and deſigned to have ſailed to
Crete, to have obtained aſſiſtance from Deucalion ſon
of Minos, and now brother-in-law to Theſeus himſelf,
he having lately married Phædra ſiſter to Deucalion.
Unfortunately, however, our hero was ſhipwrecked on 22
the iſland of Scyros. Here he was at firſt kindly received by Lycomedes the king of that iſland; but was His death.
ſoon after killed by a fall from a high rock, over which
ſome ſay he was puſhed by Lycomedes himſelf, who
had been prevailed upon to deſtroy Theſeus in that
manner by Mneſtheus, that he might with the more ſecurity enjoy the kingdom of Athens. 23

Mneſtheus reigned 24 years, but loſt his life at the Mneſtheus,
ſiege of Troy; and was ſucceeded by Demophon one Demophon,
of the ſons of Theſeus by Phædra, who was likewiſe at &c.
the ſiege of Troy, but had the good fortune to return
in ſafety. In his reign was erected the famous court
of the Ephetæ; conſiſting originally of 50 Athenians
and as many Argives, for trying of wilful murders. By
this court the king himſelf afterwards ſubmitted to be
tried for having accidentally killed one of his ſubjects.
He reigned 33 years, and was ſucceeded by his ſon, according to ſome, or according to others his brother,
Oxyntes, who reigned 12 years. Oxyntes was ſucceeded by his ſon Aphydes, who was murdered by
Thymætes the baſtard ſon of Oxyntes. 24

This king diſcovered many baſe qualities unworthy Thymætes
of his dignity; and at laſt was depoſed by his ſubjects depoſed.
on the following occaſion. Xanthus king of Bœotia
had a conteſt with the Athenians about one of their
frontier towns. He offered to decide the matter by
ſingle combat with the king; but this was declined by
Thymætes. It happened, that at that time one Melanthus a Meſſenian, who had been driven out of his
country by the Heraclidæ, was come to Athens; who
accepted the king of Bœotia's challenge. At the firſt
onſet, Melanthus aſked his adverſary, why he had, contrary to the articles, brought a ſecond into the field with
him? and as Xanthus immediately looked about to ſee
who was behind him, Melanthus run him through with
his lance. This victory, though it did little honour to
him who gained it, was ſo agreeable to the Athenians,
that they depoſed their cowardly king Thymætes, af- 25
ter he had reigned 8 years; and appointed Melanthus Melanthus.
in his ſtead, who after a reign of 37 years left the kingdom to his ſon Codrus.

This prince reigned about 21 years; during which
time the Dores and Heraclidæ had regained all Peloponneſus,

Attica.

ponnesus, and were upon the point of entering into Attica. Codrus, being informed that the oracle had promised them victory provided they did not kill the king of the Athenians, came immediately to a resolution of dying for his country. Disguising himself, therefore, like a peasant, he went into the enemy's camp, and quarrelling with some of the soldiers, was killed by them. On the morrow, the Athenians knowing what was done, sent to demand the body of their king; at which the invaders were so terrified, that they decamped without striking a blow.

26 Codrus the last king sacrifices himself for his country.

27 Republican government introduced.

Upon the death of Codrus, a dispute which happened among his sons concerning the succession, furnished the Athenians with a pretence for ridding themselves of their kings altogether, and changing the monarchical form of government into a republican one. It was improbable, they said, that they should ever have so good as king as Codrus; and to prevent their having a worse, they resolved to have no king but Jupiter. That they might not, however, seem ungrateful to the family of Codrus, they made his son Medon their supreme magistrate, with the title of *archon*. They afterwards rendered that office decennial, but continued it still in the family of Codrus. The extinction of the Medontidæ at last left them without restraint; upon which they not only made this office annual, but created nine archons. By the latter invention they provided against the too great power of a single person, as by the former they took away all apprehension of the archons having time to establish themselves, so as to change the constitution. In a word, they now attained what they had long sought, viz. the making the supreme magistrates dependant on the people.

We have a list of these archons for upwards of 600 years, beginning with Creon, who lived about 684 years before Christ, to Herodes, who lived only 60 years before that time. The first archon of whom we hear any thing worth notice, is named *Draco*. He reigned in the second, or, as others say, in the last year of the 39th Olympiad, when it is supposed he published his laws: but though his name is very frequently mentioned in history, yet no connected account can be found either of him or his institutions; only, in general, his laws were exceedingly severe, inflicting death for the smallest faults; which gave occasion to one Demades an orator to observe, that the laws of Draco were written with blood, and not with ink. For this extraordinary severity he gave no other reason, than that small faults seemed to him to be worthy of death, and he could find no higher punishment for the greatest. He was far advanced in years when he gave laws to Athens; and to give his institutions the greater weight, he would not suffer them to be called *nomoi*, or laws, but *thesmoi*, or sanctions proceeding from more than human wisdom. The extreme severity of these laws, however, soon made the Athenians weary both of them and the author of them; upon which Draco was obliged to retire to Ægina. Here he was received with the highest honours: but the favour of the inhabitants of this place proved more fatal to him than the hatred of the Athenians; for coming one day into the theatre, the audience, to show their regard, threw, as the custom then was, their cloaks upon him; and the multitude of these being very great, they stifled the old man, who was too weak to disengage himself from their load.

28 Draco legislator of Athens.

29 Expelled the city.

30 His death.

After the expulsion of Draco, nothing remarkable happened at Athens till the year before Christ 606, when we find the republic engaged in a war with the Mitylenians about the city Sigæum, situated near the mouth of the river Scamander. The Athenian army was commanded by Phrynon, a person equally remarkable for the comeliness of his person and the generosity of his mind. The Mitylenians were commanded by Pittacus, one of the celebrated sages of Greece. As these commanders looked upon the honour of their respective countries to be concerned, they exerted themselves to the utmost. At last they met in single combat: wherein Phrynon depended on his valour only: but Pittacus concealed behind his shield a net, wherewith he suddenly entangled his antagonist, and easily slew him. This, however, not putting an end to the war, Periander tyrant of Corinth interposed; and both parties having submitted to his arbitration, he decreed that Sigæum should belong to the Athenians.

Attica. 31 Mitylenian war.

About seven years after this war, a conspiracy was formed by Cylon son-in-law to Theagenes tyrant of Megara, who, having by his affable behaviour procured many friends, formed a design of seizing the sovereignty of Athens. Having consulted the oracle as to the most proper time, he was directed to make the attempt when the citizens of Athens were employed in celebrating their highest feasts to Jupiter. When many of the citizens therefore were gone to the Olympic games, Cylon and his associates made themselves masters of the citadel. Here they were instantly besieged by Megacles at that time archon, and soon reduced to great distress for want of water. The chief, together with his brother, found means to make their escape, but the meaner sort were left to shift for themselves. In this extremity they fled to the temple of Minerva; from whence Megacles with much ado prevailed upon them to come down and submit themselves to the mercy of their country. Having at last assented to this, they tied a cord to the image of the goddess, and carried the clue with them, to demonstrate, that though they were out of the temple they were still under Minerva's protection. Unfortunately for them, however, as they passed the temple of the Furies, the line snapt of itself; which Megacles construing into a renunciation by the goddess, caused his men to fall upon them and despatch as many as they could find. Such as were without the temple were immediately massacred, and those who fled thither again were murdered in their sanctuary. In short, none escaped but such as bribed the wives of the officers of justice. This carnage, however, did not put an end to the sedition. The remains of Cylon's faction created great disturbances, by insinuating that the violation of Minerva's sanctuary had drawn down the anger of the gods; and these discourses had such an effect, that Megacles and his officers were styled *execrable*, and held to be persons under the displeasure of heaven.

32 Cylon's conspiracy.

33 Conspirators massacred by Megacles;

34 who is execrated by the people.

During the time of this confusion, the Megarensians attacked Nisea, which they took, as well as Salamis; and so completely routed the Athenians in every attempt to recover the latter, that a law was at last passed, by which it should be capital for any one to propose the recovery of Salamis. About the same time the city was disturbed by reports of frightful appearances, and filled with superstitious fears; the oracle at Delphi

35 Unsuccessful war with Megara.

Delphi was therefore conſulted, and an anſwer returned that the city behoved to be expiated. Upon this, Epimenides the Pheſtian was ſent for from Crete, to perform the neceſſary ceremonies, he being reputed a holy man, and one that was deeply ſkilled in all the myſteries of religion. His expiation conſiſted in taking ſome black, and ſome white ſheep, turning them all looſe, and directing ſome perſons to follow them to thoſe places where they couched, and there to ſacrifice them to the local deity. He cauſed alſo many temples and chapels to be erected, two of which have been particularly noted, viz. the chapel of *Contumely* and that of *Impudence*. This man is ſaid to have looked wiſtfully on the port of Munychia for a long time, and then to have ſpoke as follows to thoſe that were near him: "How blind is man to future things! for did the Athenians know what miſchief will one day be derived to them from this place, they would eat it with their teeth." This prediction was thought to be accompliſhed 270 years after, when Antipater conſtrained the Athenians to admit a Macedonian garriſon into that place.

36 Epimenides's expiation and prophecy.

37 Solon the wiſe legiſlator.

About 597 years before Chriſt, Solon the famed Athenian legiſlator began to ſhow himſelf to his countrymen. He is ſaid to have been lineally deſcended from Codrus; but left by his father in circumſtances rather neceſſitous, which obliged him to apply to merchandiſe: it is plain, however, both from his words and writings, that he was a diſintereſted patriot. The ſhameful decree, that none under pain of death ſhould propoſe the recovery of Salamis, grieved him ſo much, that having compoſed an elegy of 100 verſes, ſuch as he thought would be moſt proper to inflame the minds of the people, he ran into the market-place as if he had been mad, with his night-cap on his head, repeating his elegy. A crowd being gathered round the pretended madman, his kinſman Piſiſtratus mingled among the reſt, and obſerving the people moved with Solon's words, he alſo ſeconded him with all the eloquence he was maſter of; and between them they prevailed ſo far as to have the law repealed, and a war was immediately commenced againſt the people of Megara. Who was commander in this expedition is not certain; but the city was recovered, according to the moſt general account, by the following ſtratagem. Solon coming with Piſiſtratus to Colias, and finding there the women buſy in celebrating, according to cuſtom, the feaſt of Ceres, ſent a confidant of his to Salamis, who pretended to be no friend to the people of Attica, telling the inhabitants of Salamis, that if they had a mind to ſeize the faireſt of the Athenian ladies, they might now do it by paſſing over to Colias. The Megarenſians giving eaſy credit to what the man ſaid, immediately fitted out a ſhip; which Solon perceiving from the oppoſite ſhore, diſmiſſed the women, and having dreſſed a number of beardleſs youth in female habits, under which they concealed every one a dagger, he ſent them to the ſea-ſide to dance and divert themſelves as the women were wont to do. When thoſe who came from Salamis ſaw theſe young perſons ſkipping up and down, they ſtrove who ſhould be firſt on ſhore; but were every one of them killed, and their veſſel ſeized; aboard which the Athenians embarking, ſailed immediately to Salamis and took it.

38 Salamis recovered by his means.

On the return of Solon to Athens, he was greatly honoured by the people, to whom another occaſion of admiring his wiſdom was quickly afforded. The inhabitants of Cirrha, a town ſituated in the bay of Corinth, after having by repeated incurſions waſted the territory of Delphi, at laſt beſieged the capital itſelf, with a view of making themſelves maſters of the treaſures contained in the temple of Apollo. Advice of this intended ſacrilege being ſent to the Amphictyons, who were the ſtates-general of Greece, Solon adviſed that the matter ſhould be univerſally reſented, and that all the ſtates ſhould join in puniſhing the Cirrhæans, and ſaving the Delphic oracle. This advice was complied with, and a general war againſt Cirrha declared. Clyſthenes, tyrant of Sicyon, commanded in chief, and Alcmæon was general of the Athenian quota. Solon went as aſſiſtant or counſellor to Clyſthenes, and by following his advice the war was conducted to a proſperous iſſue. For when the Greek army had beſieged Cirrha for ſome time without any appearance of ſucceſs, the oracle at Delphi was conſulted, from whence the following anſwer was returned:

39 Cirrha likewiſe reduced by Solon's wiſdom.

"In vain you hope to take the place before
"The ſea's blue waves roll o'er the hallow'd ſhore."

This anſwer ſtruck the whole army with ſurpriſe, till Solon adviſed Clyſthenes to conſecrate ſolemnly the whole territory of Cirrha to the Delphic Apollo; ſo as that was a maritime country, the ſea muſt then waſh the ſacred coaſt. According to Pauſanias, the city was reduced by the following ſtratagem, likewiſe invented by Solon. He cauſed the river Pliſtus, which run through Cirrha, to be turned into another channel, hoping thereby to have diſtreſſed the inhabitants for want of water: but finding they had many wells within the city, and were not to be reduced by that means, he cauſed a vaſt quantity of roots of hellebore to be thrown into the river, which was then ſuffered to return into its former bed. The inhabitants, overjoyed at the ſight of running water, came in troops to drink of it; whereupon an epidemic flux enſued, and the citizens being no longer able to defend the walls, the town was eaſily taken.

40 Athens in great confuſion.

On the return of Solon to Athens, he found things again in the utmoſt confuſion. The remnant of Cylon's faction gave out, that all ſorts of misfortunes had befallen the republic on account of the impiety of Megacles and his followers; which clamour was heightened by the retaking of Salamis about this time by the Megarenſians. Solon interpoſed, and perſuaded thoſe who were ſtyled *execrable* to abide a trial, and 300 perſons were choſen to judge them. The event was, that 300 of Megacles's party who were alive were ſent into perpetual baniſhment, and the bones of ſuch as were dead were dug up and ſent without the limits of their country.

41 Megacles's party baniſhed.

42 Three factions ſtart up.

Though this deciſion reſtored the public quiet for the preſent, it was not long before the people were divided into three factions, contending about the proper form of government. Theſe were called the *Diacrii*, *Pediæi*, and *Parali*; the firſt of theſe were the inhabitants of the hilly country, who declared poſitively for democracy; the ſecond, dwelling in the lower parts, and who were far more opulent than the former, declared for an oligarchy, as ſuppoſing the government would fall moſtly into their hands; the third party, who lived on

Attica.

on the sea-coast, were people of moderate principles, and therefore were for a mixed government. Besides the disturbances raised on this account, others were occasioned by the rich oppressing the poor. According to Plutarch, the poor being indebted to the rich, either tilled their grounds and paid them the sixth part of the produce, or engaged their bodies for their debts, so that many were made slaves at home, and many sold into other countries; nay, some were obliged to sell their children to pay their debts, and others in despair quitted Attica altogether. The greatest part, however, were for throwing off the yoke, and began to look about for a leader, openly declaring that they intended to change the form of government, and make a repartition of lands. In this extremity, the eyes of all the citizens were cast upon Solon. The most prudent were for offering him the sovereignty; but he perceiving their intentions, behaved in such a manner as to cheat both parties, and showed a spirit of patriotism perhaps never equalled. He refused the sovereignty as far as it might have benefited himself; and yet took upon himself all the care and trouble of a prince, for the sake of his people.

43 Solon chosen archon.

He was chosen archon without having recourse to lots, and after his election disappointed the hopes of both parties. It was Solon's fundamental maxim, That those laws will be best observed which power and justice equally support. Wherever, therefore, he found the old constitution consonant to justice in any tolerable degree, he refused to make any alteration at all, and was at extraordinary pains to show the reason of the changes he did make. In short, being a perfect judge of human nature, he sought to rule only by showing his subjects that it was their interest to obey, and not by forcing upon them what he himself esteemed best. Therefore, to a person who asked whether he had given the Athenians the best laws in his power, he replied, "I have established the best they could receive."

44 Settles all disorders.

As to the main cause of sedition, viz. the oppressed state of the meaner sort, Solon removed it by a contrivance which he called *sisachthia*, i. e. *discharge*; but what this was, authors are not agreed upon. Some say that he released all debts then in being, and prohibited the taking any man's person for payment of a debt for the future. According to others, the poor were eased, not by cancelling the debts, but by lowering the interest, and increasing the value of money; a mina, which before was made equal to 73 drachms only, being by him made equal to 100; which was of great advantage to the debtor, and did the creditor no hurt. It is, however, most probable that the sisachthia was a general remittance of all debts whatever, otherwise Solon could not have boasted in his verses that he had removed so many marks of mortgages (B) as were everywhere frequent; that he had freed from apprehension such as were driven to despair, &c.

45 Infamous behaviour of his three friends.

But in the midst of all Solon's glory, an accident befel him, which, for a time, hurt his reputation, and had almost entirely ruined his schemes. He had consulted Conon, Clinias, and Hipponicus, his three friends, on an oration prepared with a view to engage the people's consent to the discharge; and these three men, thus knowing there was to be a general discharge of debts, basely took the opportunity of borrowing vast sums before the law was promulgated, in consequence of which they were never obliged to return them.

This was thought at first to have been done with Solon's consent, and that he had shared in the money; but this aspersion was quickly wiped off when it appeared that the lawgiver himself was a very considerable loser by his own law. His friends, however, could never recover their credit, but were ever afterwards stigmatized with the opprobrious appellation of *chreocopidæ*, or *debt-sinkers*.

46 Solon blamed at first, but afterwards applauded and chosen legislator.

The Athenians were as little pleased with Solon's management as with their former condition; the rich thinking he had done too much in cancelling the money-debts due to them, and the poor that he had done too little, because he had not divided the lands of Attica equally. In a short time, however, they acquiesced in the new institutions, and gave a more public token of their repentance than they had before shown of their displeasure, instituting a solemn sacrifice under the name of *Sisachthia*, at the same time that Solon was unanimously elected legislator of Athens, with full power to make laws, and alter or new-model the constitution as he thought fit.

47 Compiles a new body of laws.

Solon being now invested with unlimited authority, set about the arduous task of compiling new laws for the turbulent people of Attica; which having at last completed in the best manner he was able, or in the best manner the nature of the people would admit, he procured them to be ratified for 100 years. Such as related to private actions were preserved on parallelograms of wood, with cases which reached from the ground, and turned about upon a pin like a wheel. These were thence called *axones*; and were placed first in the citadel, and afterwards in the prytaneum, that all the subjects might have access to them when they pleased. Such as concerned public institutions and sacrifices were contained in triangular tables of stone called *cyrbes*. The Athenian magistrates were sworn to observe both; and in process of time these monuments of Solon's wisdom became so famous, that all public acts were from them named *Axones* and *Cyrbes*.

48 He goes abroad for ten years.

After the promulgation of the laws, Solon found himself obliged to leave Athens, to prevent his being continually teazed for explanations and alterations of them. He therefore pretended an inclination to merchandise, and obtained leave to absent himself for 10 years, during which time he hoped the laws would be grown familiar. From Athens Solon travelled into Egypt, where he conversed with Psenophis the Heliopolitan, and Sonchis the Saite, the most learned priests of that age. From these he learned the situation of the island Atlantis, of which he wrote an account in verse, which Plato afterwards continued *. From

* See *Atlantis*.

(B) The Athenians had a custom of hanging up billets to show that houses were engaged for such and such sums of money.

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From Egypt he went to Cyprus, where he was extremely well received by one of the petty kings. This prince lived in a city called *Apeia*, built by Demophon the ſon of Theſeus, on an eminence near the river Clarius, but in a ſoil craggy and barren. Solon obſerving a very pleaſant plain below, engaged the king to remove thither; aſſiſted in executing the ſcheme he had formed; and ſucceeded ſo well that a new city was formed, which ſoon became populous, and out of gratitude to the Athenian legiſlator was called *Solos*.

49 Things fall into diſorder in his abſence.

But while Solon was thus travelling in queſt of wiſdom, and with a view to benefit thoſe among whom he came, his countrymen, who ſeem to have reſolved on being diſſatisfied at all events, had again divided themſelves into three factions. Lycurgus put himſelf at the head of the country people; Megacles the ſon of Alcmæon was at the head of thoſe who lived on the ſea coaſt; and Piſiſtratus put himſelf at the head of the poorer ſort, to protect them, as he pretended, from tyranny, but in reality to ſeize on the ſovereignty for himſelf. All the factions pretended to have a vaſt regard for Solon and his laws, at the ſame time that they were very deſirous of a change; but how they were to be bettered, none of them knew, or pretended to know.

50 He returns to Athens, but refuſes to reſume his office.

In the midſt of this confuſion the legiſlator returned. Each of the factions paid their court to him, and affected to receive him with the deepeſt reverence and reſpect; beſeeching him to reaſſume his authority, and compoſe the diſorders which they themſelves kept up. This Solon declined on account of his age, which, he ſaid, rendered him unable to ſpeak and act for the good of his country as formerly: however, he ſent for the chiefs of each party, beſeeching them in the moſt pathetic manner not to ruin their common parent, but to prefer the public good to their own private intereſt.

Piſiſtratus, who of all the three had perhaps the leaſt intention to follow Solon's advice, ſeemed to be the moſt affected with his diſcourſes; but as Solon perceived he affected popularity by all poſſible mothods, he eaſily penetrated into his deſigns of aſſuming the ſovereign power. This he ſpoke of to Piſiſtratus himſelf, at firſt privately; but as he ſaw that his admonitions in this way had no effect, he then ſaid the ſame things to others, that the public might be on their guard againſt him.

51 Piſiſtratus aſſumes the ſovereignty.

All the wiſe diſcourſes of Solon, however, were loſt upon the Athenians. Piſiſtratus had got the meaner ſort entirely at his devotion, and therefore reſolved to cheat them out of the liberty which they certainly deſerved to loſe. With this view he wounded himſelf, and, as Herodotus ſays, the mules that drew his chariot; then he drove into the market-place, and there ſhowed his bleeding body, imploring the protection of the people from thoſe whom his kindneſs to them had rendered his implacable enemies. A concourſe of people being inſtantly formed, Solon came among the reſt, and, ſuſpecting the deceit, openly taxed Piſiſtratus with his perfidious conduct; but to no purpoſe. A general aſſembly of the people was called, wherein it was moved by one Ariſton, that Piſiſtratus ſhould have a guard. Solon was the only perſon preſent who had reſolution enough to oppoſe this meaſure; the richer Athenians, perceiving that the multitude implicitly followed Piſiſtratus, and applauded every thing he ſaid, remaining ſilent through fear. Solon himſelf, when he ſaw he could prevail nothing, left the aſſembly, ſaying he was *wiſer* than ſome, and *ſtouter* than others. A guard of 400 men was now unanimouſly decreed to Piſiſtratus, as we are told by Solon himſelf. This inconſiderable body he made uſe of to enſlave the people, but in what manner he accompliſhed his purpoſe is not agreed. Certain it is, that with his guard he ſeized the citadel; but Polyænus hath given an account of a very ſingular method which he took to put it out of the power of the Athenians to defend themſelves even againſt ſuch a ſmall number. He ſummoned an aſſembly to be held at the Anacium, and directed that the people ſhould come thither armed. They accordingly came; and Piſiſtratus harangued them, but in a voice ſo low that they could not tell what he ſaid. The people complaining of this, Piſiſtratus told them that they were hindered from hearing him by the clangour of their arms; but if they would lay them down in the portico, he would then be heard diſtinctly. This they did; and while they liſtened very attentively to a long and eloquent oration, Piſiſtratus's guard conveyed away their arms, ſo that they found themſelves deprived of all power of reſiſtance. During the confuſion 52 Solon leaves Athens. which followed this event, another aſſembly was held, wherein Solon inveighed bitterly againſt the meanneſs of his countrymen, inviting them to take up arms in defence of their liberty. When he ſaw that nothing would do, he laid down his own arms, ſaying, that he had done his utmoſt for his country and his laws. According to Plutarch, he refuſed to quit the city; but the moſt probable opinion is, that he immediately retired from the dominion of Athens, and refuſed to return, even at the ſolicitation of Piſiſtratus himſelf.

Piſiſtratus, having thus obtained the ſovereignty, did 53 Piſiſtratus governs with great moderation. not overturn the laws of Solon, but uſed his power with the greateſt moderation. It is not to be expected, however, that ſo turbulent a people as the Athenians could be ſatisfied by any method of government he could lay down. At the beginning of his adminiſtration, Megacles and his family retired out of Athens to ſave their own lives, yet without deſpairing of being able ſome time or other to return. With this view Megacles and his aſſociates entered into a treaty with Lycurgus; and having brought him and his party into a ſcheme for depoſing Piſiſtratus, they concerted matters ſo well, that Piſiſtratus was ſoon obliged to ſeek 54 Driven out by Megacles. for ſhelter ſomewhere elſe, and, on his departure, the Athenians ordered his goods to be ſold. Nobody, however, except one perſon (*Callias*), would venture to buy any of them, from an apprehenſion, no doubt, that they would ſoon be reſtored to their proper owner, which accordingly happened in a very ſhort time.

As Megacles and his party had negociated with Lycurgus 55 Who ſoon after reinſtates him. to turn out Piſiſtratus, ſo they now entered into a treaty with Piſiſtratus to reinſtate him in his principality, as ſoon as they found Lycurgus would not be implicitly governed by them. To accompliſh this, they fell upon a very ridiculous project; which, however, was attended with the deſired ſucceſs. They found out a woman whoſe name was *Phya*, of a mean family and fortune, but of a great ſtature, and very handſome.

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Her they dreſſed in armour, placed her in a chariot, and having diſpoſed things ſo as to make her appear with all poſſible advantage, they conducted her towards the city, ſending heralds before, with orders to ſpeak to the people in the following terms: "Give a kind reception, O Athenians, to Piſiſtratus, who is ſo much honoured by Minerva above all other men, that ſhe herſelf condeſcends to bring him back to the citadel." The report being univerſally ſpread that Minerva was bringing home Piſiſtratus, and the ignorant multitude believing this woman to be the goddeſs, addreſſed their prayers to her, and received Piſiſtratus with the utmoſt joy. When he had recovered the ſovereignty, Piſiſtratus married the daughter of Megacles as he had promiſed, and gave the pretended goddeſs to his ſon Hipparchus.

56
Driven out a ſecond time;

Piſiſtratus did not long enjoy the kingdom to which he had been reſtored in ſo ſtrange a manner. He had married the daughter of Megacles, as already obſerved; but having children by a former wife, and remembering that the whole family of Megacles was reprobated by the Athenians, he thought proper to let his new ſpouſe remain in a ſtate of perpetual widowhood. This ſhe patiently bore for ſome time, but at laſt acquainted her mother. An affront ſo grievous could not fail to be highly reſented. Megacles inſtantly entered into a treaty with the malcontents, of whom there were always great plenty at Athens whatever was the form of government. This Piſiſtratus being apprized of, and perceiving a new ſtorm gathering, he voluntarily quitted Athens, and retired to Eretria. Here having conſulted with his ſons, it was reſolved to reduce Athens by force. With this view he applied to ſeveral of the Greek ſtates, who furniſhed him with the troops he deſired, but the Thebans exceeded all the reſt in their liberality; and with this army he returned to Attica, according to Herodotus, in the 11th year of his baniſhment. They firſt reduced Marathon, the inhabitants of which had taken no meaſures for their defence, though they knew that Piſiſtratus was preparing to attack them. The republican forces in the mean time marched out of Athens to attack him; but behaving in a ſecure and careleſs manner, they were ſurpriſed by Piſiſtratus, and totally routed. While they were endeavouring to make their eſcape, he cauſed his two ſons to ride before him with all ſpeed, and tell thoſe they came up with that nobody had any thing to fear, but that they might every one return to his own home. This ſtratagem ſo effectually diſperſed the republican army, that it was impoſſible to rally them, and Piſiſtratus became a third time abſolute maſter of Attica.

57
but returns with an army.

58
He takes poſſeſſion of the city.

59
His ſubjects ſtill diſcontented notwithſtanding his moderation.

Piſiſtratus being once more in poſſeſſion of the ſovereignty, took a method of eſtabliſhing himſelf on the throne directly oppoſite to what Theſeus had done. Inſtead of collecting the inhabitants from the country into cities, Piſiſtratus made them retire from the cities into the country, in order to apply themſelves to agriculture. This prevented their meeting together, and caballing againſt him in ſuch bodies as they had been accuſtomed to do. By this means alſo the territory of Athens was greatly meliorated, and great plantations of olives were made over all Attica, which had before not only been deſtitute of corn, but alſo bare of trees. He alſo commanded, that, in the city, men ſhould wear a kind of ſheep-ſkin veſt, reaching to the knees; but ſo intolerable were the laws of Piſiſtratus to his ſubjects, that this kind of garment in ſucceeding times became proverbially the habit of ſlavery.

As prince of Athens, Piſiſtratus received the tenth part of every man's revenues, and even of the fruits of the earth; and this alſo, though for the ſervice of the ſtate, ſeemed to the Athenians a moſt grievous burden. In ſhort, though Piſiſtratus behaved in all reſpects as a moſt excellent prince, his ſubjects fancied themſelves oppreſſed by tyranny, and were perpetually grumbling from the time he firſt aſcended the throne to the day of his death, which happened about 33 years after he had firſt aſſumed the ſovereignty, of which time, according to Ariſtotle, he reigned 17 years.

60
Hipparchus and Hippias.

Piſiſtratus left behind him two ſons named *Hipparchus* and *Hippias*, both men of great abilities, who ſhared the government between them, and behaved with lenity and moderation. But though by the mildneſs of their government the family of the Piſiſtratidæ ſeemed to be fully eſtabliſhed on the throne of Athens, a conſpiracy was unexpectedly formed againſt both the brothers, by which Hipparchus was taken off, and Hippias narrowly eſcaped. The moſt material facts relating to this conſpiracy are what follow.

61
Conſpiracy of Harmodius and Ariſtogiton:

There were at that time in Athens two young men, called *Harmodius* and *Ariſtogiton;* the former of theſe was exquiſitely beautiful in his perſon, and on that account, according to the infamous cuſtom of the Greeks, violently beloved of the other. This Harmodius was alſo beloved of Hipparchus; who, if we may believe Thucydides, forced him. This was grievouſly reſented, and revenge determined on; to haſten which, another accident concurred. Hipparchus, finding that Harmodius endeavoured to avoid him, publicly affronted him, by not ſuffering his ſiſter to carry the offering of Minerva, as if ſhe was a perſon unworthy of that office. The two young men, not daring to ſhow any public ſigns of reſentment, conſulted privately with their friends; among whom it was reſolved, that at the approaching feſtival of Panathenæa, when the citizens were allowed to appear in arms, they ſhould attempt to reſtore Athens to its former liberty. In this they imagined that they ſhould find themſelves ſeconded by the whole body of the people. But when the day appointed was come, they perceived one of their number talking very familiarly with Hippias; and fearing that they were diſcovered, they immediately fell upon Hipparchus, and deſpatched him with a multitude of wounds. In this exploit the people were ſo far from ſeconding them, as they expected, that they ſuffered Harmodius to be killed by Hipparchus's guards, and ſeizing Ariſtogiton themſelves, delivered him up to Hippias. Some time afterwards, however, the reſpect they paid to theſe two young men exceeded all bounds. They cauſed their praiſes to be ſung at the Panathenæa, forbade any citizen to call a ſlave by either of their names, and erected brazen ſtatues to them in the forum; which ſtatues were afterwards carried into Perſia by Xerxes, and ſent back from thence by Alexander the Great, Antiochus, or Seleucus, for authors are not agreed by which. Several immunities and privileges were alſo granted to the deſcendants of theſe

62
Hipparchus killed.

63
The conſpirators extravagantly honoured.

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theſe two patriots, and all poſſible means were taken to render their memory venerable and reſpected by poſterity.

64 Cruelty of Hippias.

Hippias being now ſole maſter of Athens, and probably exaſperated by the murder of his brother, began to alter his conduct greatly, and treat his ſubjects in an oppreſſive and cruel manner. He began with torturing Ariſtogiton, in order to make him confeſs his accomplices: but this proved fatal to his own friends: for Ariſtogiton impeaching ſuch as he knew to be beſt affected to Hippias, they were immediately put to death; and when he had deſtroyed all thoſe he knew, at laſt told Hippias, that now he knew of none that deſerved to ſuffer death except the tyrant himſelf. Hippias next vented his rage on a woman named *Leæna*, who was kept by Ariſtogiton. She endured the torture as long as ſhe could; but finding herſelf unable to bear it any longer, ſhe at laſt bit off her tongue, that ſhe might not have it in her power to make any diſcovery. To her the Athenians erected the ſtatue of a lioneſs, alluding to her name, without a tongue, on which was engraved a ſuitable inſcription.

After the conſpiracy was, as Hippias thought, thoroughly quaſhed, he ſet himſelf about ſtrengthening his government by all the means he could think of. He contracted leagues with foreign princes, increaſed his revenues by various methods, &c. But theſe precautions were of little avail; the lenity of Piſiſtratus's government had alone ſupported it; and Hippias purſuing contrary methods, was deprived of his ſovereignty in leſs than four years after the death of his brother.

65 He is driven out of Athens;

This revolution was likewiſe owing to the family of Megacles, who were ſtyled *Alcmæonidæ*, and had ſettled at Lipſydrum. In times of diſcontent, which at Athens were very frequent, this family was the common refuge of all who fled from that city; and at laſt they thought of a method of expelling the Piſiſtratidæ altogether. The method they took to accompliſh their purpoſe was as follows. They agreed with the Amphictyons to rebuild the temple at Delphi; and being poſſeſſed of immenſe riches, they performed their engagement in a much more magnificent manner than they were bound to do; for having agreed only to build the front of common ſtone, they built it of Parian marble. At the ſame time they corrupted the propheteſs Pythia, engaging her to exhort all the Lacedemonians that came to conſult the oracle either in behalf of the ſtate, or their own private affairs, to attempt the delivery of Athens. This had the deſired effect: the Lacedemonians, ſurpriſed at hearing this admonition inceſſantly repeated, at laſt reſolved to obey the divine command, as they imagined it to be; and ſent Anchimolius, a man of great quality, at the head of an army into Attica, though they were at that time in league with Hippias, and accounted by him his good friends and allies. Hippias demanding aſſiſtance from the Theſſalians, they readily ſent him 1000 horſe, under the command of one of their princes named *Sineas*. The Lacedemonians being landed, Hippias fell upon them ſo ſuddenly, that he defeated them with great ſlaughter, killed their general, and forced the ſhattered remains of their army to fly to their ſhips. The Spartans, incenſed at this unfortunate expedition, determined to ſend another army into Attica; which they accordingly did ſoon after under their king Cleomenes: and he having, at his entrance into the Athenian territories, defeated the Theſſalian horſe, obliged Hippias to ſhut himſelf up in the city of Athens, which he was ſoon after forced to abandon altogether. He was, however, in no want of a place of refuge; the Theſſalian princes inviting him into their country, and the king of Macedon offering his family a city and territory, if they choſe to retire into his dominions. But Hippias choſe rather to go to the city of Sigeum, which Piſiſtratus had conquered, and left to his own family. 66 and retires to Sigeum.

67 Two factions in Athens.

After the expulſion of the Piſiſtratidæ, the Athenians did not long enjoy the quiet they had propoſed to themſelves. They were quickly divided into two factions; at the head of one was Clyſthenes, one of the chief of the Alcmæonidæ; and of the other, Iſagoras, a man of great quality, and highly in favour with the Athenian nobility. Clyſthenes applied himſelf to the people, and endeavoured to gain their affection by increaſing their power as much as poſſible. Iſagoras perceiving that by this means his rival would get the better, applied to the Lacedemonians for aſſiſtance, reviving at the ſame time the old ſtory of Megacles's ſacrilege, and inſiſting that Clyſthenes ought to be baniſhed as being of the family of Megacles. Cleomenes king of Sparta readily came into his meaſures, and ſuddenly deſpatched a herald to Athens with a declaration of war in caſe all the Alcmæonidæ were not immediately baniſhed. The Athenians did not heſitate to baniſh their benefactor Clyſthenes, and all his relations; but this piece of ingratitude did not anſwer their purpoſe. Cleomenes entered Attica at the head of a Spartan army; and, arriving at Athens, condemned to baniſhment 700 families more than what had been ſent into exile before. Not content with this, he would have diſſolved the ſenate, and veſted the government in 300 of the chief of Iſagoras's faction. This the Athenians would by no means ſubmit to; and therefore took up arms, and drove Cleomenes and his troops into the citadel, where they were beſieged for two days. On the third day Cleomenes ſurrendered, on condition that all thoſe who were in the citadel ſhould retire unmoleſted. This, though agreed to, was not performed by the Athenians. They fell upon ſuch as were ſeparated from the army, and put them to death without mercy. Among the number of thoſe ſlain on this occaſion was Timeſitheus the brother of Cleomenes himſelf. 68 The Spartans ſupport Iſagoras;

69 but without ſucceſs.

The Spartan king was no ſooner withdrawn from Athens, than he formed a ſtrong combination in favour of Iſagoras. He engaged the Bœotians to attack Attica on the one ſide, and the Chalcidians on the other, while he at the head of a powerful Spartan army entered the territories of Eleuſina. In this diſtreſs, the Athenians, not being able to cope with ſo many enemies at once, reſolved to ſuffer their territories to be ravaged by the Chalcidians and Bœotians, contenting themſelves with oppoſing the army commanded by Cleomenes in perſon. But this powerful confederacy was quickly diſſolved: the Corinthians, who were allied with Cleomenes, doubting the juſtice of their cauſe, returned home; his other allies likewiſe beginning to waver, and his colleague Ariſton, the other king of Sparta, differing in ſentiments, Cleomenes

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menes was obliged to abandon the enterprife. The Spartans and their allies being withdrawn, the Athenians took a fevere revenge of the Bœotians and Chalcidians, totally routing their forces, and carrying off a great number of prifoners. The prifoners taken in this war were put in irons, but afterwards fet at liberty on paying a ranfom of two minæ per head. Their fetters were, however, hung up in the citadel; and the Athenians confecrating the tenth of what they had received for ranfom, purchafed a ftatue, reprefenting a chariot and four horfes, which they fet up in the portico of the citadel, with a triumphant infcription in token of their victory.

70 Bœotians and Chalcidians defeated.

These indignities roufing the Bœotians, they immediately vowed revenge, and engaged on their fide the people of Ægina, who had an hereditary hatred at the Athenians; and while the latter bent all their attention to the Bœotian war, the Æginetans landing a confiderable army, ravaged the coafts of Attica.

71 Attempt of the Spartans to reftore Hippias.

But while the Athenians were thus employed againft the Bœotians and Æginetans, a jealoufy fprung up on the part of Lacedemon, which was never afterwards eradicated. Cleomenes, after his unfuccefsful expedition againft Attica, produced at Sparta certain oracles which he faid he had found in the citadel of Athens while he was befieged therein: the purport of thefe oracles was, that Athens would in time become a rival to Sparta. At the fame time it was difcovered, that Clyfthenes had bribed the prieftefs of Apollo to caufe the Lacedemonians to expel the Pififtratidæ from Athens; which was facrificing their beft friends to thofe whom intereft obliged to be their enemies. This had fuch an effect, that the Spartans, repenting their folly in expelling Hippias, fent for him from Sigeum, in order to reftore him to his principality: but this not being agreed to by the reft of the ftates, they were forced to abandon the enterprife, and Hippias returned to Sigeum as he came.

72 Caufe of the war with Perfia.

About this time, too, Ariftagoras the Milefian having fet on foot a revolt in Ionia againft the Perfian king, applied to the Spartans for affiftance; but they declining to have any hand in the matter, he next applied to the Athenians, and was by them furnifhed with 20 fhips under the command of Melanthus, a nobleman univerfally efteemed. This rafh action coft the Greeks very dear, as it brought upon them the whole power of the Perfian empire; for no fooner did the king of Perfia hear of the affiftance fent from Athens to his rebellious fubjects, than he declared himfelf the fworn enemy of that city, and folemnly befought God that he might one day have it in his power to be revenged on them.

The Ionian war being ended, by the reduction of that country again under the Perfian government, the king of Perfia fent to demand earth and water as tokens of fubmiffion from the Greeks. Moft of the iflanders yielded to this command out of fear, and among the reft the people of Ægina; upon which the Athenians accufed the inhabitants of this ifland of treachery towards Greece, and a war was carried on with them for a long time. How it ended we are not informed; but its continuance was fortunate for Greece in general, as, by inuring them to war, and fea-affairs in particular, it prevented the whole of the Grecian ftates from being fwallowed up by the Perfians who were now about to invade them.

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Befides the difpleafure which Darius had conceived againft the Athenians on account of the affiftance they had afforded the Ionians, he was further engaged to an expedition againft Greece by the intrigues of Hippias. Immediately on his returning unfuccefsfully from Lacedemon, as above related, Hippias paffed over into Afia, went to Artaphernes governor of the adjacent provinces belonging to the Perfian king, and excited him to make war upon his country, promifing to be obedient to the Perfian monarch provided he was reftored to the principality of Athens. Of this the Athenians being apprifed, fent ambaffadors to Artaphernes, defiring leave to enjoy their liberty in quiet: but that nobleman returned for anfwer, that if they would have peace with the great king, they muft immediately receive Hippias; upon which anfwer the Athenians refolved to affift the enemies of Darius as much as poffible. The confequence of this refolution was, that Darius commiffioned Mardonius to revenge him of the infults he thought the Greeks had offered him. But Mardonius having met with a ftorm at fea, and other accidents which rendered him unable to do any thing, Datis and Artaphernes the fon of Artaphernes above-mentioned, were commiffioned to do what he was to have done.

73 Hippias applies to the Perfians.

The Perfian commanders, fearing again to attempt to double the promontory of Athos, where their fleet had formerly fuffered, drew their forces into the plains of Cilicia; and paffing from thence through the Cyclades to Eubœa, directed their courfe to Athens. Their charge from Darius was to deftroy both Eretria and Athens; and to bring away the inhabitants, that they might be at his difpofal. Their firft attempt was on Eretria, the inhabitants of which fent to Athens for affiftance on the firft approach of the Perfian fleet. The Athenians, with a magnanimity almoft unparalleled at fuch a juncture, fent 4000 men to their affiftance; but the Eretrians were fo much divided amongft themfelves, that nothing could be refolved on. One party among them was for receiving the Athenian fuccours into the city; another, for abandoning the city and retiring into the mountains of Eubœa; while a third fought to betray their country to the Perfians for their own private intereft. Seeing things in this fituation, therefore, and that no good could poffibly be done, one Æfchines, a man of great authority among the Eretrians, generoufly informed the Athenian commanders that they might return home. They accordingly retired to Oropus, by which means they efcaped deftruction: for Eretria being foon after betrayed to the Perfians, was pillaged, burnt, and its inhabitants fold for flaves.

74 They invade Greece.

75 Eretria deftroyed.

On the news of this difafter the Athenians immediately drew together all the forces they were able, which after all amounted to no more than 9000 men. Thefe, with 1000 Platæans who afterwards joined them, were commanded by ten general officers, who had equal power; among whom were Miltiades, Ariftides, and Themiftocles, men of diftinguifhed valour and great abilities. But it being generally imagined that fo fmall a body of troops would be unable to refift the formidable power of the Perfians, a meffenger was difpatched

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patched to Sparta to entreat the immediate aſſiſtance of that ſtate. He communicated his buſineſs to the ſenate in the following terms: "Men of Lacedemon, the Athenians deſire you to aſſiſt them, and not to ſuffer the moſt ancient of all the Grecian cities to be enſlaved by the barbarians. Eretria is already deſtroyed, and Greece conſequently weakened by the loſs of ſo conſiderable a place." The aſſiſtance was readily granted; but at the ſame time the ſuccours arrived ſo ſlowly, that the Athenians were forced to fight without them. In this memorable engagement in the plains of Marathon, whither Hippias had conducted the Perſians, the latter were defeated with the loſs of 6300 men, while the Greeks loſt only 192. The Perſians being thus driven to their ſhips, endeavoured to double Cape Sunium, in ordered to ſurpriſe Athens itſelf before the army could return: but in this they were prevented by Miltiades; who, leaving Ariſtides with 1000 men to guard the priſoners, returned ſo expeditiouſly with the other 9000, that he was at the temple of Hercules, which was but a ſmall way diſtant, before the barbarians could attack the city.

76 Perſians defeated at Marathon.

77 Integrity of Ariſtides.

After the battle, Ariſtides diſcharged the truſt repoſed in him with the greateſt integrity. Though there was much gold and ſilver in the Perſian camp, and the tents and ſhips they had taken were filled with all ſorts of riches, he not only forbore touching any thing himſelf, but to the utmoſt of his power prevented others from doing it. Some, however, found means to enrich themſelves; among the reſt, one Callias, couſin-german to Ariſtides himſelf. This man being a torch-bearer, and, in virtue of his office, having a fillet on his head, one of the Perſians took him for a king, and, falling down at his feet, diſcovered to him a vaſt quantity of gold hid in a well. Callias not only ſeized, and applied it to his own uſe, but had the cruelty to kill the poor man who diſcovered it to him, that he might not mention it to others; by which infamous action he entailed on his poſterity the name of *Laccopluti* or *enriched by the well*.

78 Miltiades ungratefully treated by the Athenians.

After the battle of Marathon, all the inhabitants of Platæa were declared free citizens of Athens, and Miltiades, Themiſtocles, and Ariſtides, were treated with all poſſible marks of gratitude and reſpect. This, however, was but very ſhortlived; Miltiades propoſed an expedition againſt the iſland of Paros, in which having being unſucceſsful, through what cauſe is not well known, he was, on his return, accuſed, and condemned to pay 50 talents, the whole expence of the ſcheme; and, being unable to pay the debt, was thrown into priſon, where he ſoon died of a wound received at Paros.

79 As likewiſe Ariſtides.

If any thing can exceed the enormity of ſuch a proceeding as this, it was the treatment Ariſtides next received. Miltiades had propoſed an expedition, which had not proved ſucceſsful, and in which he might poſſibly have had bad deſigns; but againſt Ariſtides not ſo much as a ſhadow of guilt was pretended. On the contrary, his extraordinary virtue had procured him the title of *Juſt*, and he had never been found to ſwerve from the maxims of equity. His downfal was occaſioned by the intrigues of Themiſtocles; who being a man of great abilities, and hating Ariſtides on account of the character he deſervedly bore among his countrymen, took all opportunities of inſinuating, that his rival had in fact made himſelf maſter of Athens without the parade of guards and royalty. "He gives laws to the people (ſaid he); and what conſtitutes a tyrant, but giving laws?" In conſequence of this ſtrange argument, a ſtrong party was formed againſt the virtuous Ariſtides, and it was reſoved to baniſh him for 10 years by the oſtraciſm. In this caſe, the name of the perſon to be baniſhed was written upon a ſhell by every one who deſired his exile, and carried to a certain place within the forum encloſed with rails. If the number of ſhells ſo collected exceeded 6000, the ſentence was inflicted; if not, it was otherwiſe. When the agents of Themiſtocles had ſufficiently accompliſhed their purpoſes, on a ſudden the people flocked to the forum, deſiring the oſtraciſm. One of the clowns who had come from a borough in the country, bringing a ſhell to Ariſtides, ſaid to him, "Write me Ariſtides upon this." Ariſtides, ſurpriſed, aſked him if he knew any ill of that Athenian, or if he had ever done him any hurt? "Me hurt! (ſaid the fellow, no, I don't ſo much as know him; but I am weary and ſick at heart on hearing him everywhere called *the juſt*." Ariſtides, therefore, took the ſhell, and wrote his own name upon it; and when informed that the oſtraciſm fell upon him, modeſtly retired out of the forum, ſaying, "I beſeech the gods that the Athenians may never ſee that day which ſhall force them to remember Ariſtides."

After the battle of Marathon, the war with Ægina was revived with great vigour; but the Æginetans generally had the ſuperiority, on account of their great naval power. Themiſtocles obſerving this, was continually exhorting his countrymen to build a fleet, not only to make them an equal match for the Æginetans, but alſo becauſe he was of opinion that the Perſians would ſoon pay them another viſit. At laſt, he had the boldneſs to propoſe, that the money produced by the ſilver mines, which the Athenians had hitherto divided among themſelves ſhould be applied to the building of a fleet: which propoſal being complied with, 100 galleys were immediately put upon the ſtocks; and this ſudden increaſe of their maritime power proved the means of ſaving all Greece from ſlavery.

80 Themiſtocles adviſes the building of a fleet.

81 Xerxes invades Greece.

About three years after the baniſhment of Ariſtides, Xerxes king of Perſia ſent to demand earth and water: but Themiſtocles deſiring to make the breach with that monarch ſtill wider, put to death the interpreter for publiſhing the decree of the king of Perſia in the language of the Greeks; and having prevailed upon the ſeveral ſtates to lay aſide their animoſities, and provide for their common ſafety, got himſelf elected general of the Athenian army.

When the news arrived that the Perſians were advancing to invade Greece by the ſtraits of Thermopylæ, and that they were for this purpoſe tranſporting their forces by ſea, Themiſtocles adviſed his countrymen to quit the city, embark on board their galleys, and meet their enemies while yet at a diſtance. This they would by no means comply with; for which reaſon Themiſtocles put himſelf at the head of the army, and having joined the Lacedemonians, marched towards Tempe. Here, having received advice that the ſtraits of Thermopylæ were forced, and that both Bœotia and

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Thessaly had submitted to the Persians, the army returned without doing any thing.

In this distress the Athenians applied to the oracle at Delphi: from whence they received at first a very severe answer, threatening them with total destruction; but after much humiliation, a more favourable one was delivered, in which, probably by the direction of Themistocles, they were promised safety in *walls of wood.* This was by Themistocles and the greatest part of the citizens interpreted as a command to abandon Athens, and put all their hopes of safety in their fleet. Upon this, the opinion of Themistocles prevailing, the greatest part began to prepare for this embarkation; and had money distributed among them by the council of the Areopagus, to the mount of eight drachms per man: but this not proving sufficient, Themistocles gave out that somebody had stolen the shield of Minerva; under pretence of searching for which, he seized on all the money he could find. Some, however, there were who refused to embark with the rest, but raised to themselves fortifications of wood; understanding the oracle in its literal sense, and resolving to wait the arrival of the Persians, and defend themselves to the last. In the mean time Aristides was recalled, when the Athenians saw it their interest, lest he should have gone over to the Persians and assisted them with his advice.

82 Athens abandoned by its inhabitants,

83 and destroyed by the Persians.

The Persians having advanced to Athens soon after the inhabitants had deserted it, met with no opposition except from a few just now mentioned; who, as they would hearken to no terms of accommodation, were all cut in pieces, and the city utterly destroyed. Xerxes, however, being defeated in a sea fight at Salamis, was forced to fly with prodigious loss. See SALAMIS. Themistocles was for pursuing him, and breaking down the bridge he had cast over the Hellespont; but this advice being rejected, he sent a trusty messenger to Xerxes, acquainting him that the Greeks intended to break down his bridge, and therefore desired him to make all the haste he could, lest by that means he should be shut up in Europe. According to Herodotus, he also advised the Athenians to quit the pursuit and return home, in order to build their ruined houses. This advice, though misinterpreted by some, was certainly a very prudent one, as Xerxes, though once defeated, was still at the head of an army capable of destroying all Greece; and had he been driven to despair by finding himself shut up or warmly pursued, it was impossible to say what might have been the event. After this, Themistocles formed a scheme, for the aggrandisement of Athens indeed, but a most unjust and infamous one. It was, in short, to make Athens mistress of the sea, by burning all the ships except those belonging to that republic. He told his countrymen, that he had something to propose of great consequence, but which could not be spoken publicly: whereupon he was desired to communicate it to Aristides, by whom the proposal was rejected; and Aristides having informed the Athenians that what Themistocles had said was very advantageous but very unjust, they desired him to think no more of it.

84 They are totally defeated at Salamis.

85 Themistocles honoured by the Lacedemonians.

When the fleet returned to Salamis, extraordinary honours were paid to Themistocles by the Lacedemonians. On his entering that city, they decreed him a wreath of olives as the prize of prudence; presented him with the most magnificent chariot in Sparta: and when he returned to Athens, he was escorted by 500 horse, an honour never paid to any stranger but himself. On his arrival at Athens, however, there were not wanting some who insinuated that the receiving such honours from the Lacedemonians was injurious to the republic; but Themistocles, confiding in his innocence, treated these clamours with contempt, and exhorted his countrymen to entertain no doubts of their allies, but rather endeavour to preserve the great reputation they had acquired throughout all Greece.

The defeat of Xerxes at Salamis made Mardonius, who was left to carry on the war by land, more ready to treat with the Athenians than to fight them; and with this view he sent Alexander king of Macedon to Athens to make proposals of alliance with that republic, exclusively of all the other Grecian states. This proposal, however, was rejected; and the consequence was, that Athens was a second time destroyed, the Spartans sending assistance so slowly, that the Athenians were forced to retire to Salamis; but they were soon freed from all apprehensions by the total defeat and death of Mardonius at Platæa; where Aristides, and the body of troops under his command, distinguished themselves in a most extraordinary manner.

86 Athens a second time destroyed.

87 The Persians defeated at Platæa and Mycale.

The same day that the battle of Platæa was fought, the Persians were defeated in a sea-fight at Mycale in Ionia, wherein it was allowed that the Athenians who were there behaved better than any of the other Greeks; but when it was proposed to transport the Ionians into Europe, that they might be in perfect safety, and give them the territories of such Grecian states as had sided with the Persians, the Athenians refused to comply, fearing the Ionians would rival them in trade, or refuse the obedience they used to pay them; besides which, they would then lose the opportunity of plundering the Persians in case of any quarrel with Ionia. Before they returned home, however, the Athenians crossed over to the Chersonesus, and besieged Sestos. The siege was long and troublesome: but at last the garrison, being pressed with hunger, and having no hopes of relief, divided themselves into two bodies, and endeavoured to make their escape; but were pursued, and all either killed or taken. *Oibazus*, one of their commanders, was sacrificed to a Thracian god; and the other, called *Artyactes*, impaled alive, and his son stoned before his face, because he had rifled the sepulchre of Protesilaus.

88 Sestos taken by the Athenians.

After the victories at Platæa and Mycale, the Athenians returned without any apprehension, and began to rebuild their city in a more magnificent manner than before. Here they were no sooner arrived than a dispute was ready to be commenced about the form of government. The commons, with Themistocles at their head, were for a democracy; to which Aristides, rather than hazard the raising disturbances, consented. It was therefore proposed, that every citizen should have an equal right to the government; and that the archons should be chosen out of the body of the people, without preference or distinction: and this proposal being agreed to, put an end to all discontents for the present.

89 They rebuild their city.

At this time also Themistocles proposed that the city of Athens should be fortified in the best manner possible, that it might not be liable to be again destroyed, when

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when the Perſians ſhould take it into their heads to invade Greece. At this propoſal the Lacedemonians were exceedingly alarmed; and therefore remonſtrated, that ſhould Athens once be ſtrongly fortified, and the Perſians become poſſeſſed of it, it would be impoſſible to get them out of it again. At laſt, ſeeing theſe arguments had no effect, they abſolutely forbade the Athenians to carry their walls any higher. This command gave great offence; but Themiſtocles, conſidering the power of Sparta at that time, adviſed the Athenians to temporize; and to aſſure the ambaſſadors, that they ſhould proceed no farther in their work, till, by an embaſſy of their own, ſatisfaction ſhould be given to their allies. Being named ambaſſador at his own deſire to Sparta, with ſome other Athenians, Themiſtocles ſet out alone, telling the ſenate that it would be for the intereſt of the ſtate to delay ſending the other ambaſſadors as long as poſſible. When arrived at Sparta, he put off from time to time receiving an audience, on account of his colleagues not being arrived: but in the mean time the walls of Athens were building with the utmoſt expedition; neither houſes nor ſepulchres being ſpared for materials; and men, women, children, ſtrangers, citizens, and ſervants, working without intermiſſion. Of this the Lacedemonians having notice and the reſt of the Athenian ambaſſadors being arrived, Themiſtocles and his colleagues were ſummoned before the ephori, who immediately began to exclaim againſt the Athenians for their breach of promiſe. Themiſtocles denied the charge: he ſaid his colleagues aſſured him of the contrary: that it did not become a great ſtate to give heed to vague reports, but that deputies ought to be ſent from Sparta to inquire into the truth of the matter, and that he himſelf would remain as a hoſtage, to be anſwerable for the event. This being agreed to, he engaged his aſſociates to adviſe the Athenians to commit the Spartan ambaſſadors to ſafe cuſtody till he ſhould be releaſed; after which he publicly avowed the whole tranſaction, took the ſcheme upon himſelf, and told the Lacedemonians that "all things are lawful for our country." The Spartans, ſeeing no remedy, concealed their reſentment, and ſent Themiſtocles home in ſafety.

90 Themiſtocles adviſes to fortify Athens, and deceives the Spartans who oppoſe it.

91 Makes the Pyræus the port of Athens.

The next year, being the laſt of the 75th Olympiad, Themiſtocles obſerving the inconvenience of the port Phalerum, thought of making the *Pyræus* the port of Athens. This he did not at firſt think proper to mention publicly; but having ſignified to the people that he had ſomething of importance to communicate, they appointed Xanthippus and Ariſtides to judge of his propoſal. They readily came into his meaſures, and told the people that what Themiſtocles propoſed would be of the utmoſt advantage to the ſtate, at the ſame time that it might be performed with eaſe. Upon this they were deſired to lay the matter before the ſenate; who coming unanimouſly into their meaſures, ambaſſadors were deſpatched to Sparta to inſinuate there how proper it would be for the Greeks to have ſome great port, where a fleet might always watch the deſigns of the Perſians; and thus having prevented any umbrage from their firſt undertakings, the work was ſet about with ſuch expedition, that it was finiſhed before the Lacedemonians knew well what they were about.

At this time alſo the ſovereignty of the ſea was transferred from Sparta to Athens, through the haughty behaviour of Pauſanias the Lacedemonian. He had commanded at Platæa, and ſtill enjoyed the ſupreme authority in the war which was all this time carrying on againſt the Perſians; but being elated with his ſucceſs at Platæa, and having entered into a treaſonable correſpondence with the enemy, he treated the captains under his command with the greateſt haughtineſs, giving the preference to the Spartans in ſuch a manner that the reſt of the Greeks could no longer bear his inſolence. On the contrary, Ariſtides, and Cimon the ſon of Miltiades, who commanded the Athenians, by their obliging behaviour gained the favour of every body; ſo that the allies, having publicly affronted Pauſanias, put themſelves under the protection of the Athenian republic; and thenceforward the Athenians, and not the Lacedemonians, had the ſupreme command.

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92 Sovereignty of the ſea transferred to Athens.

93 Ariſtides taxes Greece with extraordinary applauſe.

The Greeks being now ſenſible that they would always have occaſion to be on their guard againſt the Perſians, and that it was neceſſary to eſtabliſh a fund by a common taxation of all the ſtates, Ariſtides was pitched upon as the only perſon that could be truſted with the power of allotting to each of the ſtates its proper quota. This difficult taſk he undertook, and executed in a manner unparalleled in the annals of hiſtory. All parties were pleaſed, and his taxation was ſtyled *the happy lot of Greece*. The groſs amount of it was 450 talents.

94 Themiſtocles baniſhed.

It now came to the turn of Themiſtocles to experience the ingratitude of his countrymen. His ſervices had been ſo eſſential, that the treatment he received may perhaps be a ſufficient excuſe for modern patriots when they connect their own intereſt with the ſervice of their country. Themiſtocles had plainly ſaved the ſtate from ruin by his advice; he had diſtinguiſhed himſelf by his valour; had rendered Athens, by his policy, ſuperior to the other ſtates of Greece; and entirely ſubverted the Lacedemonian ſcheme of power. Yet notwithſtanding all this, he was baniſhed by the oſtraciſm, without the ſmalleſt crime pretended, unleſs that he was hated by the Lacedemonians, and that he had erected a temple, near his own houſe, dedicated to *Diana, the giver of the beſt counſel*; intimating that he himſelf had given the beſt counſel for the ſafety both of Athens and of all Greece, which was no more than the truth. Nay, he was not only driven out of Athens, but out of all Greece; ſo that he was forced to ſeek ſhelter from the king of Perſia, againſt whom he had fought with ſo much valour. That monarch gave him a gracious reception; and he was never recalled, becauſe the Greeks had no occaſion for his ſervices.

95 Succeſs of Cimon againſt the Perſians.

The war with Perſia was not yet diſcontinued; the Greeks found their advantage in plundering and enriching themſelves with the ſpoils of the king of Perſia's ſubjects. For this reaſon, in the end of the 77th Olympiad, they equipped a navy, under a pretence of relieving ſuch of the Greek cities in Aſia as were ſubject to the Perſians. Of this fleet Cimon, the ſon of Miltiades by the daughter of the king of Thrace, was appointed commander in chief. He had already taſted the juſtice and generoſity of his countrymen, having been thrown into priſon for his father's fine, from which he was releaſed by *Callias*, whom his ſiſter Elpinice married on account of his great wealth procured by no very honourable means. He accepted of the command,

however,

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however, and gained ſuch immenſe booty in this expedition, that the Athenians were thereby enabled to lay the foundation of thoſe long extended walls which united the port to the city. The foundation was laid in a mooriſh ground; ſo that they were forced to ſink it very deep, and at a great expence; but to this Cimon himſelf contributed out of his own ſhare of the ſpoils, which was very conſiderable. He alſo adorned the forum with palm-trees, and beautified the academy with delightful walks and fountains.

96 He ſubdues the Cherſoneſus.

The Perſians having ſoon after this expedition invaded Cherſoneſus, and with the aſſiſtance of the Thracians made themſelves maſters of it, Cimon was ſent againſt them in a great hurry. He had only four ſhips; but nevertheleſs with theſe he took 13 of the Perſian galleys, and reduced the whole of the Cherſoneſus. After this he marched againſt the Thracians, who revolting againſt the Athenians, had made themſelves maſters of the gold mines lying between the rivers Nyſſus and Strymon. The Thracians were quickly obliged to yield; after which the Athenians ſent a great colony to Amphipolis, a city of Thrace, which for ſome time made a conſiderable figure, but afterwards attempting to penetrate into the country of the *Edones*, great part of them were deſtroyed.

97 Makes Athens irreſiſtible at ſea.

Cimon alſo fell upon the following expedient to make Athens irreſiſtible at ſea by the other ſtates of Greece. Many of the Greek ſtates, by virtue of Ariſtides's taxation, were bound to furniſh men and galleys as well as to pay the tax for their ſupport. But when they ſaw themſelves out of danger from the Perſians, moſt of them were very unwilling to furniſh their quota of men. This the Athenian generals being offended with, were for having recourſe to force; but Cimon permitted ſuch as were deſirous of ſtaying at home to do ſo, and accepted a ſum of money in lieu of a galley completely manned. By this means he inured the Athenians, whom he took on board his galleys, to hardſhip and diſcipline; while the allies who remained at home became enervated through idleneſs, and from being confederates, dwindled into tributaries, and almoſt ſlaves. In the laſt year of the 77th Olympiad, Cimon was ſent to aſſiſt the Lacedemonians againſt their Helotes, who had revolted from them. In this he was attended with his uſual ſucceſs; but, ſome time after, the Lacedemonians being engaged in the ſiege of Ithome, ſent again to the Athenians for ſuccour, and Cimon was a ſecond time ſent to their relief; but the Spartans having received a ſufficient ſupply of troops from other quarters before the arrival of the Athenian general, he and his men were diſmiſſed without doing any thing. This grievouſly offended the people of Athens, who thenceforward hated not only the Lacedemonians, but all their own citizens who were thought to be friends to that ſtate.

98 He is baniſhed.

It was not poſſible, however, that any perſon who had ſerved the ſtate ſhould eſcape baniſhment at Athens. Cimon had gained great wealth both to the public and to himſelf. In his public character he had behaved with unimpeached honeſty, and as a private citizen he dedicated his wealth to the moſt excellent purpoſes. He demoliſhed the encloſures about his grounds and gardens, permitting every one to enter and take what fruits they pleaſed; he kept an open table, where both rich and poor were plentifully entertained. If he met a citizen in a tattered ſuit of clothes, he made ſome of his attendants exchange with him; or if the quality of the perſon rendered that kindneſs unſuitable, he cauſed a ſum of money to be privately given him. All this, however, was not ſufficient: he did not concur with every meaſure of the commonalty; and therefore the popular party determined not to baniſh him, but to put him to death. The crime laid to his charge was, that by preſents from the Macedonians he was prevailed upon to let ſlip a manifeſt opportunity of enlarging his conqueſts, after taking from the Perſians the gold mines of Thrace. To this accuſation Cimon replied, that to the utmoſt of his power he had proſecuted the war againſt the Thracians, and other enemies of the ſtate of Athens; but that, it was true, he had not made any inroads into Macedonia, becauſe he did not imagine he was to act as a public enemy of mankind, and becauſe he was ſtruck with reſpect for a nation modeſt in their carriage, juſt in their dealings, and ſtrictly honourable in their behaviour towards him and the Athenians: that if his countrymen looked upon this as a crime, he muſt abide their judgment; but, for his part, he could never be brought to think ſuch conduct amiſs. Elpinice, Cimon's ſiſter, uſed all her intereſt in his behalf, and amongſt others ſpoke to Pericles the celebrated ſtateſman and orator. He was indeed Cimon's rival, and had no doubt aſſiſted in ſtirring up the proſecution againſt him; but he did not deſire his death: and therefore, though appointed to accuſe him, Pericles ſpoke in ſuch a manner that it plainly appeared he did not think him guilty; and, in conſequence of this lenity, Cimon was only baniſhed by the oſtraciſm.

The Athenian power was now riſen to ſuch a height, that all the other ſtates of Peloponneſus looked upon this republic with a jealous eye, and were continually watching every opportunity of making war upon it when the ſtate was engaged in troubleſome affairs, and ſeemed to be leſs able to reſiſt. Theſe attempts, however, ſo far from leſſening, generally contributed to increaſe, the power of the Athenians; but in the year before Chriſt 458, the republic entered into a war with Sparta, which was ſcarce put an end to but by the deſtruction of the city of Athens. For this war, there was no recent provocation on the part of the Spartans. They had ſent a great army to aſſiſt the Dorians againſt the Phocians, and the Athenians took this opportunity to revenge themſelves of former quarrels. Having therefore drawn in the Argives and Theſſalians to be their confederates, they poſted themſelves on the iſthmus, ſo that the Spartan army could not return without engaging them. The Athenians and their confederates amounted to 14,000 and the Spartans to 11,500. The Spartan general, however, not very willing to hazard a battle, turned aſide to Tanagra, a city in Bœotia, where ſome of the Athenians who inclined to ariſtocracy entered into a correſpondence with him. But before their deſigns were ripe for execution, the Athenian army marched with great expedition to Tanagra, ſo that a battle became inevitable. When the armies were drawn up in order of battle, Cimon, preſented himſelf before his countrymen in complete armour, and went to take poſt among thoſe of his own tribe, but the popular party raiſed ſuch a clamour againſt him, that he was forced to retire. Before he departed, however, he exhorted Euthippus and the reſt of his friends to behave in ſuch a manner that they

99 War between Athens and Sparta.

100 Athenians defeated.

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might wipe off the aſperſion thrown upon him, as if he had deſigned to betray his country's cauſe to the Lacedemonians. Euthippus deſired him to leave his armour, which he did; and a battle enſuing, the Athenians were defeated with great loſs, and Euthippus with the reſt of Cimon's friends were all killed in defence of his armour which they had ſurrounded. Another engagement ſoon followed, wherein both armies ſuffered ſo much, that they were glad to conclude a ſhort truce, that each might have time to recruit their ſhattered forces.

101 They gain great advantages over the Spartans.

The ſcale of fortune now ſeemed to turn in favour of the Athenians. The Thebans, who had been deprived of the command of Bœotia on account of their having ſided with Xerxes, were now reſtored to it by the Lacedemonians. At this the Athenians were ſo diſpleaſed, that they ſent an army under Myronides the ſon of Callias into Bœotia to overturn all that had been done. That general was met by the Thebans and their allies, who compoſed a numerous and well-diſciplined army. Nevertheleſs, though the Athenians army was but an handful in compariſon of their enemies, Myronides gained a complete victory over the allies, in ſome ſenſe more glorious than either that of Marathon or Platæa. In theſe battles they had fought againſt effeminate and ill-diſciplined Perſians, but now they encountered and defeated a ſuperior army compoſed of the braveſt Greeks. After this victory, Myronides marched to Tanagra; which he took by ſtorm, and razed to the ground: he then plundered Bœotia; defeated another army which the Bœotians had drawn together to oppoſe him: then fell upon the Locrians; and, having penetrated into Theſſaly, chaſtiſed the inhabitants of that country for having revolted from the Athenians; and from thence returned to Athens laden with riches and glory.

The next year Tolmides the Athenian admiral invaded Laconia, where he made himſelf maſter of ſeveral places; and on the back of this, Pericles invaded Peloponneſus with great ſucceſs, burning, ſpoiling, or taking, whatever places he attempted. On his return he found the people greatly out of humour on account of Cimon's baniſhment; ſo he was immediately recalled.

102 Cimon recalled.

Cimon was no ſooner returned than he fell to his old employment of plundering the Perſians; and, according to Plutarch, he had now nothing leſs in view than the conqueſt of the whole Perſian empire. The Perſian monarch finding he could have no reſt, at laſt ſent orders to Artabazus and Megabizus, his commanders, to conclude a treaty; which was done on the following conditions: 1. That the Greek cities in Aſia ſhould be free, and governed by their own laws. 2. That the Perſians ſhould ſend no army within three days journey of the ſea. 3. That no Perſian ſhip of war ſhould ſail between Theſalis and Cyrene, the former a city of Pamphylia, and the latter of Lycia.

103 His death.

While this treaty was carrying on Cimon died, whether of ſickneſs or of a wound he had received is not known; and after his death the Athenian affairs began to fall into confuſion. It was now the misfortune of this ſtate to be alike hated by her enemies and allies; the conſequence of which was, that the latter were perpetually revolting whenever they thought they had an opportunity of doing ſo with impunity. The Megarians, at this time, who had been long under the protection or dominion of Athens, thought proper for ſome reaſon or other to diſclaim all dependence on their former protectors, and have recourſe to Sparta, with which ſtate they entered into a ſtrict alliance. This the Athenians revenged by ravaging the country of the Megarians; which ſoon brought on a renewal of the Lacedemonian war that had been for a little time ſuſpended. Pericles, however, procured the return of the firſt Lacedemonian army, without bloodſhed, by bribing Chandrides the young king of Sparta's tutor. In the winter, Tolmides reſolved to undertake an expedition into Bœotia with a ſmall body of troops: which deſign he put in execution contrary to the advice of Pericles; and his raſhneſs was ſoon puniſhed by his own death and the total defeat of his army. Notwithſtanding this misfortune, however, Pericles ſoon after invaded and reduced Eubœa: and the Lacedemonians, finding it was not for their intereſt to carry on the war, concluded a truce with the Athenians for 30 years.

104 A thirty years truce with the Lacedemonians.

About this time Pſammiticus, king of Egypt, ſent by way of preſent to the people of Athens 40,000 buſhels of wheat; which proved a great misfortune to the city: for Pericles, out of ſpite to Cimon, who had children by an Arcadian woman, had preferred a law whereby the Athenians of the half blood were disfranchiſed; and this law, on account of the diſtribution of the corn above-mentioned, was proſecuted with ſuch ſeverity, that no leſs than 5000 perſons, who till then had been conſidered as free-men, were ſold for ſlaves. This piece of cruelty has been of great ſervice to the critics, as by means of it we know exactly the number of Athenian citizens, which at this time amounted to no more than 14,040 perſons, though Athens was now aiming at no leſs than erecting an univerſal monarchy.

105 Cruelty of Pericles.

106 Number of the Athenian citizens.

Six years after the concluſion of the peace between Athens and Sparta, a war broke out between the Samians and Mileſians about the city of Priene, ſeated under Mount Mycale in Ionia. How this war came to affect the Athenians is not certainly known; but, ſomehow or other, this republic was induced to take the part of the Mileſians; and the iſland of Samos was reduced by Pericles, who eſtabliſhed there a democracy, and left an Athenian garriſon. He was no ſooner gone, however, than the Samians diſliking their new form of government, drove out the garriſon he had left; but Pericles quickly returning, beſieged and took their city, demoliſhed their walls, and fined them of the whole expence of the war; part of which he obliged them to pay down, and took hoſtages for the remainder. When Pericles returned, he procured himſelf to be appointed to pronounce the public oration in honour of thoſe who fell: which he did with ſuch eloquence, that when he came down from the pulpit the women gathered about him, took him by the hand, and crowned him with garlands.

107 Samos reduced by Pericles.

A little after this commenced the war between the Corcyrians and Corinthians, which by degrees brought the Athenians into thoſe engagements that proved the ruin of their ſtate. The cauſes of this war were the following. An inteſtine war breaking out in the little territory of Epidamnum, a city of Macedonia founded by the Corcyrians, one party called in to their aſſiſtance

108 War between the Corcyrians and Corinthians.

Attica. ſiſtance the Illyrians, and the other the Corcyrians. The latter neglecting the matter, Corinth was applied to, as the Corcyrians were a colony from that place. The Corinthians, partly out of pity to the Epidamnians, and partly out of ſpleen to the Corcyrians, ſent a very great fleet to the aſſiſtance of the former, by which means that party which had applied to Corinth was thoroughly eſtabliſhed. This being reſented by the Corcyrians, they ſent a fleet to Epidamnum to ſupport the exiles; and accordingly this fleet began to act offenſively on its entering the port, the chief commanders having inſtructions to propoſe terms of accommodation, to which the Corinthians would by no means agree. The next year the Corcyrians defeated at ſea the Corinthians and their allies, and took Epidamnum by ſtorm; after which they waſted the territories of the allies of the Corinthians, which greatly exaſperated the latter. At Corinth, therefore, they began to make great preparations for carrying on the war, and preſſed their confederates to do the ſame, that they might be in a condition to retrieve the honour they had loſt, and humble this ungrateful colony which had thus inſulted her mother city.

The Corcyrians were no ſooner acquainted with theſe proceedings, than they deſpatched ambaſſadors to Athens with their complaints; and theſe were quickly followed by others from Corinth on the ſame errand.

109
Athens ſides with the Corcyrians.

At firſt the people of Athens inclined to favour the Corinthians; but they ſoon changed their minds, and took part with the Corcyrians: they contented themſelves, however, with entering into a defenſive alliance with that little ſtate, whereby they promiſed to aſſiſt each other, in caſe either party ſhould be attacked; and in conſequence of this treaty, they furniſhed the Corcyrians with ten galleys, under Lacedæmonius the ſon of Cimon, with whom were joined Diotenes and Proteus as colleagues.

As ſoon as the ſeaſon of the year permitted, the Corinthians ſailed for the coaſt of Corcyra with a fleet of 150 ſhips, under the command of Xenoclides, aſſiſted by four other Corinthian admirals; each ſquadron of their allies being commanded by a chief of their own. The Corcyrian and Athenian fleet amounted to 120, but the Athenians had orders to give as little aſſiſtance as poſſible. The action was very briſk for ſome time: the Corcyrian right wing broke the left of the Corinthian fleet; and forcing ſome of the ſhips on ſhore, landed, pillaged their camp, and made a great number of them priſoners: on the other hand, the Corinthian ſhips in the right wing beat the Corcyrian ſhips there, they being but very faintly aſſiſted by the Athenians, till the latter were at laſt obliged to defend themſelves, which they did ſo well, that the Corinthians were glad to retire. The next day preparations were made on both ſides for another engagement; but 20 ſhips coming from Athens to the aſſiſtance of the Corcyrians, the Corinthians declined the combat.

110
Potidæa beſieged by the Athenians.

As ſoon as the Corcyrian war broke out, the Athenians ſent orders to the citizens of Potidæa to demoliſh a part of their wall, to ſend back the magiſtrates they had received from Corinth, and to give hoſtages for their own behaviour. Potidæa was a town in Macedonia, founded by the Corinthians, but at that time in alliance with the Athenians.—Perdiccas king of Macedon, who hated the Athenians, took this opportunity to perſuade the Potidæans to revolt. Accordingly they ſent ambaſſadors to Athens to entreat the revocation of theſe orders; but at the ſame time ſent deputies to Sparta, to join with the Corinthians and Megarians in their complaints againſt the Athenians. The Athenians upon this ſent a conſiderable fleet againſt Potidæa, under the command of Calias, a nobleman of great courage. The Corinthians on their part deſpatched one Ariſteus with a conſiderable body of troops to the aſſiſtance of that city. An engagement following, the Athenians were victors, but with the loſs of their general. Phormio, who ſucceeded in the command, inveſted the city in form, and ſhut up its port with his fleet; but the Potidæans dreading to fall into the hands of the Athenians, made a moſt obſtinate defence, while in the mean time they warmly ſolicited the Corinthians to perform their promiſes, and engage the reſt of the ſtates of Peloponneſus in their quarrel.

111
The Spartans demand reparation for the injuries offered to the ſtates of Greece.

The Lacedemonians having heard what the Corinthians and other little ſtates of Greece had to ſay againſt the Athenians, ſent ambaſſadors to the latter, demanding reparation for the injuries, with orders, in caſe of a refuſal, to declare war. The terms demanded were, in the firſt place, the expulſion of thoſe Athenians who were allied to the family of Megacles ſo often mentioned. This article was on account of Pericles; for he was the ſon of Xanthippus the Athenian commander at Mycale by Agariſte niece to the famous Clyſthenes, who corrupted the prieſteſs of Apollo in order to procure the expulſion of the Piſiſtratidæ. They next inſiſted that the ſiege of Potidæa ſhould be raiſed; thirdly, that the inhabitants of Ægina ſhould be left free; and laſtly, that a decree made againſt the Megarians, whereby they were forbid the ports and markets of Athens, ſhould be revoked, and all the Grecian ſtates under the dominion of Athens ſet at liberty.

112
Their terms rejected by advice of Pericles.

Theſe terms the Athenians were perſuaded by Pericles to reject. The arguments uſed by him were in ſubſtance as follows: That whatever the Lacedemonians might pretend as to the juſtice of the complaints of the allies, the true ground of this reſentment was the proſperity of the Athenian republic, which the Spartans always hated, and now ſought an opportunity of humbling: that it muſt be owing to the Athenians themſelves if this deſign ſucceeded, becauſe for many reaſons Athens was better able to engage in a long and expenſive war than the Peloponneſians. He then laid before the people an exact account of their circumſtances; putting them in mind, that the treaſure brought from Delos amounted to 10,000 talents; and that though 4000 of theſe had been expended on the ſtately gate of their citadel, yet that 6000 were ſtill in hand; that they were alſo entitled to the ſubſidies paid by the confederate ſtates; that the ſtatues of their gods, the Perſian ſpoils, &c. were worth immenſe ſums; that private men were arrived at vaſt fortunes; and that, conſidering their trade by ſea, they had a certain annual increaſe of wealth; that they had on foot an army of 12,000 men, and in their colonies and garriſons 17,000; that their fleet conſiſted of 300 ſail; whereas the Peloponneſians had no ſuch advantages. For theſe reaſons he propoſed as the moſt feaſible and likewiſe

Attica. likewiſe the moſt equitable ſatisfaction that could be given, that they would reverſe their decree againſt Megara, if the Lacedemonians would allow free egreſs and regreſs in their city to the Athenians and their allies; that they would leave all thoſe ſtates free who were free at the making of the laſt peace with Sparta, provided the Spartans would alſo leave all ſtates free who were under their dominion; and that future diſputes ſhould be ſubmitted to arbitration. In caſe theſe offers ſhould be rejected, he adviſed them to hazard a war; telling them, that they ſhould not think they ran that hazard for a trifle, or retain a ſcruple in their minds as if a ſmall matter moved them to it, becauſe on this ſmall matter depended their ſafety, and the reputation of their conſtancy and reſolution; whereas, if they yielded in this, the next demand of the Lacedemonians would be of a higher nature; for having once diſcovered that the Athenians were ſubject to fear, they would thence conclude that nothing could be denied to Sparta; whereas a ſtiff denial in this caſe would teach them to treat Athens for the future on terms of equality. He enforced theſe reaſons by ſhowing that their anceſtors had always acted on the like principles, and in all caſes preferred their glory to their eaſe, and their liberty to their poſſeſſions.

113 Attempt of the Thebans on Platæa.

This was the origin of the Peloponneſian war, which makes ſo great a figure in ancient hiſtory. The immediate preliminary to general hoſtilities was an attempt of the Thebans to ſurpriſe Platæa. With this view they ſent Eurymachus with 300 Thebans to aſſiſt ſuch of the Platæans as they had drawn over to their intereſt, in making themſelves maſters of the place. In this deſign they ſucceeded very well at firſt, the Platæans, who had promiſed to open the gates, keeping their words exactly, ſo that they were inſtantly in poſſeſſion of the city. The other party, however, perceiving how ſmall a number they had to contend with, unanimouſly roſe upon them, killed a great many, and forced the reſt to ſurrender themſelves priſoners of war. Another party came from Thebes to aſſiſt their countrymen; but they arrived too late: the Platæans, however, foreſeeing that they would waſte their country, promiſed to releaſe their priſoners if they would forbear to ſpoil their lands. On this the Thebans withdrew; and the Platæans cruelly put to death all their priſoners, to the number of 180, with Eurymachus their chief, alleging that they had not promiſed their releaſe but in caſe of peace. The Athenians, as ſoon as they had notice of this attempt of the Thebans, cauſed all the Bœotians in their territory to be arreſted; and when they underſtood how the Platæans had delivered themſelves, they ſent a great convoy of proviſions to that city, and a numerous body of troops to eſcort their wives and children to Athens.

114 They are maſſacred.

115 Account of the allies on both ſides.

Both parties now prepared in earneſt for war, both ſent ambaſſadors to the Perſians, and both ſought to rouſe their allies. Moſt of the Greek ſtates inclined to favour the Spartans, becauſe they acted on this occaſion as the deliverers of Greece, and becauſe they either had been, or feared that they would be, oppreſſed by the Athenians. With the Spartans joined all the Peloponneſians, except the Argives and part of the Achæans; without Peloponneſus, the Megarians, Phocians, Locrians, Bœotians, Ambraciots, Leucadians, and Anactorians, declared themſelves on their ſide. On the other hand, the Chians, Leſbians, Platæans, Meſſenians, Acarnanians, Corcyrians, Zacynthians, Carians, Dorians, Thracians, moſt part of the iſlands, and all the Cyclades excepting Melos and Thera, with Eubœa and Samos, joined the Athenians.

116 First year of the war.

The Peloponneſian war commenced 431 years before Chriſt. The Lacedemonian army was aſſembled at the iſthmus, and conſiſted of no leſs than 60,000 men; but before Archidamus king of Sparta, who commanded in chief, would enter Attica, he deſpatched a herald to Athens. The herald was ſent back without any anſwer, by which all hopes of peace were cut off. As Archidamus was a friend to Pericles, the latter apprehended that he might forbear plundering his eſtates. With this he immediately acquainted the people; telling them at the ſame time, that in ſuch a caſe he made a preſent of his lands to the public. He then adviſed the citizens to take no care of defending their country-ſeats, but to attend only to the city, buſy themſelves in the equipping of ſhips, and ſettle a thorough reſolution not to be intimidated with the firſt evils of war. This propoſal the Athenians readily complied with, and appointed Pericles commander in chief, with nine more generals to aſſiſt him.

The firſt year, the Spartan army committed great ravages in Attica, Pericles having no force capable of oppoſing it, and refuſing to engage on diſadvantageous terms, notwithſtanding prodigious clamours were raiſed againſt him by his countrymen. The allies, however, had no great reaſon to boaſt of the advantages they gained this year: an Athenian fleet ravaged the coaſts of Peloponneſus; another infeſted the Locrians, drove out the inhabitants of Ægina, and repeopled the iſland from Athens. They likewiſe reduced Cephalenia, and ſome towns in Acarnania and Leucas which had declared for the Lacedemonians; and in the autumn, when the Peleponneſians were retired, Pericles entering the Megarian territory, did all the miſchief that could be expected from a provoked enemy.

117 Second year. A dreadful plague at Athens.

The ſpring of the ſecond year was very fatal to Athens by a dreadful plague which deſtroyed great numbers of the citizens, while the Peloponneſians under Archidamus waſted every thing abroad. In the midſt of theſe diſtreſſes, however, Pericles retained his courage, and would ſuffer none of his countrymen to ſtir without the city either to eſcape the plague or infeſt the enemy. He cauſed a great fleet to be equipped, on board which he embarked 4000 foot and 300 horſe, with which he ſailed to Epidaurus. Upon this the enemy withdrew their forces out of Attica; but Pericles was able to do no great matter on account of the plague, which made ſo great havock among his men, that he brought back to Athens only 1500 of the 4000 he carried out. By this misfortune the Athenians were thrown into deſpair; they immediately ſued for peace, which the Spartans were now too proud to grant; then turning their rage upon Pericles, they diſmiſſed and fined him. Soon after, Pericles's children and almoſt all his relations died of the plague; ſo that this great ſtateſman was overwhelmed with melancholy, and for ſome time ſhut himſelf up from public view: at laſt, through the perſuaſion of Alcibiades and ſome others, he ſhowed himſelf to the people. They received him with acclamations, and at his requeſt repealed the unjuſt

118 Athenians ſue for peace.

Attica. just law he had made, whereby all Athenians of the half blood were disfranchised, and then reinstated him in all his former honours. Hereupon he inrolled the only son he had left, who before had been counted a bastard on account of his mother being a Milesian.

119 Pericles requests the repeal of his law.

This year also the island of Zacynthus was wasted by the Peloponnesians; and the city of Potidæa submitted to the Athenians, after the inhabitants had been driven to such extremity as to feed upon human flesh. The Athenians permitted the men to depart with one garment, and the women with two; after which, the town was repeopled by a colony from Athens.

120 Third year. Pericles dies.

The third year of the Peloponnesian war was remarkable for the death of the great Pericles, who was taken off by the plague. Platæa also was besieged by Archidamus; but without success, even though the greatest part of it was set on fire; the Platæans resolving to submit to every kind of misery rather than abandon the Athenian cause. In the end, therefore, the king of Sparta was obliged to turn the siege into a blockade; and having thrown up an intrenchment fortified with a deep ditch, he left a sufficient number of men to guard his lines, and then returned back to Peloponnesus.

121 Platæa besieged.

122 Fourth year. Desperate attempt of the Platæans.

The following summer, the Peloponnesians under the command of Archidamus invaded Attica, where they wasted every thing with fire and sword; at the same time the whole island of Lesbos, except the district of Methymna, revolted from the Athenians, who hereupon invested the city of Mitylene. All this time the city of Platæa was blocked up by the Peloponnesians; and its inhabitants being now greatly distressed for want of provisions, the garrison, consisting of 400 natives and 80 Athenians, came to the desperate resolution of forcing a passage through the enemy's lines. When they came to attempt this, however, many of them were intimidated: but 300 persisted in their resolution; and of these 212 got safe through and marched to Athens, but the rest were compelled to retire.

123 Fifth year. Mitylene, &c. taken by the Athenians.

In the beginning of the fifth year, the Peloponnesians sent 40 ships to the relief of Mitylene; but without effect, for the place had surrendered before the fleet could come to its assistance. Paches, the Athenian commander, likewise chased away the Peloponnesian fleet upon its arrival, and returning to Lesbos sent the Lacedemonian minister, whom he found in Mitylene, together with a deputation, to Athens. On their arrival, the Lacedemonian was immediately put to death; and in a general assembly of the people, it was resolved, that all the Mitylenians who were arrived at man's estate should be put to death, and the women and children sold for slaves. The next day, however, this cruel decree was reversed, and a galley sent with all expedition to countermand the bloody orders. This last vessel, however, could not get before the other: but Paches, being a man of great humanity, had taken a day to consider on the orders he had received; during which time the last mentioned galley arrived; in consequence of which, only about 1000 of the most forward rebels were put to death; the walls of the city were also demolished, their ships taken away, and their lands divided among the Athenians, who let them again to their old masters at very high rents. The same summer the Athenians seized the island of Minoa, lying over against the territory of Megara; and likewise the port of Nisæa, which last they fortified, and it proved afterwards a place of the utmost importance to them. At this time also the Platæans, driven to the last extremity, surrendered to the Lacedemonians, by whom they were, to the number of 208, including 25 Athenians, put to death, and their women sold for slaves. Their city was soon after razed by their implacable enemies the Thebans, who left only an inn to show where it stood. The fame of Platæa, however, induced Alexander the Great afterwards to rebuild it.

124 Platæa taken and razed.

125 Sedition of Corcyra

In this year happened the famous sedition of Corcyra, whence other seditions, when their effects rendered them terrible, have been called *Corcyrian*. It hath been already observed, that the war between the Corcyrians and Corinthians brought on the general war throughout Peloponnesus. A great number of Corcyrians were in the beginning of this war carried away prisoners into Peloponnesus, where the chief of them were very well treated, but the rest sold for slaves. The reason of this conduct of the Corinthians was a design they had formed of engaging these Corcyrians to influence their countrymen to side with them and their allies. With this view they treated them with all imaginable lenity and tenderness, instilling into them by degrees an hatred of democratic government; after which they were told, that they might obtain their liberty upon condition of using all their influence at home in favour of the allies, and to the prejudice of Athens. This the Corcyrians readily promised and endeavoured to perform. At first, those who were for an aristocracy prevailed, and murdered all those of the opposite party that fell into their hands, in which they were assisted by a fleet of Peloponnesians: but the Athenians sending first one fleet and then another to the assistance of the distressed party, the Peloponnesians were forced to withdraw; after which the democratic party sufficiently revenged themselves, and destroyed their antagonists without mercy. The worst of all was, that this example once set, the several states of Greece felt in their turns the like commotions, which were always heightened by agents from Sparta and Athens; the former endeavouring to settle aristocracy, and the latter democracy, wherever they came.

126 Athenians engage in a war with Sicily.

While the Athenians were thus engaged in a war wherein they were already overmatched, they foolishly engaged in a new one, which in the end proved more fatal than all the rest. The inhabitants of Sicily were split into two factions; the one called the *Doric*, at the head of which was the city of Syracuse; the other the *Ionic*, which owned the Leontines for their chiefs: the latter perceiving themselves too weak without foreign aid, sent one Georgias, a celebrated orator, to apply to Athens for relief; and he by his fine speeches so captivated the giddy and inconstant Athenians, that they ran headlong into a war which they were unable to maintain while engaged with all the Peloponnesians. Enticed by this new prospect, therefore, and grasping at the conquest of Sicily, as well as of all Greece, they sent a fleet to the assistance of the Leontines, under the command of Lachetes and Chabrias; and they were no sooner sailed, than another fleet for the same purpose was begun to be fitted out. All this time the plague continued to rage with great violence at Athens, cutting off this year 4000 citizens, besides

Attica.

ſides a much greater number of the meaner ſort of people.

127 Sixth year.

The ſixth year of the Peloponneſian war was remarkable for no great exploit: Agis the ſon of Archidamus, king of Sparta, aſſembled an army in order to invade Attica, but was prevented from ſo doing by many great earthquakes which happened throughout Greece. The next year, however, he entered Attica with his army, while the Athenians on their part ſent

128 Seventh year.

a fleet under the command of Demoſthenes, to infeſt the coaſts of Peloponneſus. As this fleet paſſed by La-

Pylus fortified by the Athenians.

conia, the commander took notice that the promontory of Pylus, which was joined to the continent by a narrow neck of land, had before it a barren iſland about two miles in circumference, in which, however, there was a good and ſafe port, all winds being kept off by the headland, or by the iſle. Theſe advantages made him apprehend, that a garriſon left here would give the Peloponneſians ſo much trouble, that they would find it more adviſable to protect their own country than to invade that of their neighbours. Accordingly, having raiſed a ſtrong fortification, he himſelf with five ſhips ſtaid to defend it, while the reſt of the fleet proceeded on their intended expedition. On the

129 Beſieged.

news of this event, the Peloponneſian army immediately returned to beſiege Pylus. When they arrived before the place they took poſſeſſion of the harbour, and then cauſed a choſen body of Spartans take poſſeſſion of the iſland of Sphacteria, after which they attacked the fort with great vigour. Demoſthenes and his garriſon defended themſelves with great valour;

130 Spartan fleet deſtroyed.

and an Athenian fleet arriving very ſeaſonably, offered battle to the Peloponneſian fleet. This being refuſed, the Athenians boldly ſailed into the harbour, broke and ſunk moſt of the veſſels therein, after which they beſieged the Spartans in Sphacteria. The Peloponneſians now began to treat with their enemies, and a truce was concluded during the time that negociations were carried on at Athens. One of the articles of this truce was, that the Peloponneſians ſhould deliver up all their ſhips, on condition of having them punctually returned in caſe the treaty did not take effect. The Athenians having heard the Spartan ambaſſadors, were inclined to put an end to this deſtructive war: but Cleon, one of their orators, a warm and obſtinate man, perſuaded his countrymen to inſiſt on very unreaſonable terms; upon which the ambaſſadors

131 Treachery of the Athenians.

returned, and by doing ſo put an end to the truce. The Peloponneſians then demanded their veſſels; but the Athenians refuſed to deliver them, under pretence of their having broke the truce.

132 They attack Sphacteria.

Hoſtilities being thus recommenced on both ſides, the Lacedemonians attacked the Athenians at Pylus, while the latter attacked the Spartans at Sphacteria. The Spartans, though but a handful of men and under every imaginable diſcouragement, behaved with ſuch bravery, that the ſiege proceeded very ſlowly, ſo that

133 Cleon the orator appointed general.

the people of Athens became very uneaſy. They began then to wiſh they had embraced the offers of the Spartans, and to rail vehemently againſt Cleon, who, to excuſe himſelf, ſaid, it would be eaſy for the general of the forces they were at that time ſending, to attack the Spartans in the iſle, and reduce them at once. Nicias, who had been appointed to this command, replied, that if Cleon believed he could do ſuch great things, he would do well to go thither in perſon: the latter, imagining this only meant to try him, ſaid he was ready to go with all his heart; whereby Nicias catched him, and declared that he had relinquiſhed his charge. Cleon thereupon ſaid, that he was no general; but Nicias told him that he might become one; and the people, pleaſed with the controverſy, held the orator to his word. Cleon then advancing, told them he was ſo little afraid of the enemy, that, with a very inconſiderable force, he would undertake, in conjunction with thoſe already at Pylus, to bring to Athens the Spartans who gave them ſo much trouble in 20 days. The people laughed at theſe promiſes: however, they furniſhed him with the troops he deſired; and to their ſurpriſe, Cleon brought the Spartans priſoners to Athens within the time appointed.

134 He takes the place.

135 End of the Corcyrian ſedition.

This ſummer, likewiſe, an Athenian fleet was ſent to Sicily, with inſtructions to put in at Corcyra, and aſſiſt the government againſt the Lacedemonian faction which ſtill ſubſiſted in that iſland. This they effectually performed; for by their means the exiles fell into the hands of the other party: theſe they impriſoned; and then drew them out by 20 at a time, to ſuffer death, which was inflicted with all the circumſtances of cruelty that party-rage could ſuggeſt. When only 60 remained, they entreated the Athenians to put them to death, and not to deliver them up to their countrymen; but upon this the Corcyrians ſurrounded the place where they were confined, endeavouring to bury them under their darts; upon which the unhappy captives all put an end to their own lives.

136 Eighth year. Succeſs of the Athenians.

In the eighth year Nicias reduced the iſle of Cythera on the coaſt of Laconia; as likewiſe Thyræa, on the confines of that country. The latter had been given to the Æginetans when expelled from their own country by the Athenians: and they were now condemned to death, as inveterate enemies of the Athenian ſtate and nation.—In Sicily, one Hermocrates of Syracuſe perſuaded all the inhabitants of the iſland to adjuſt their differences among themſelves; upon which the Athenian generals returned home, and for ſo doing two of them were baniſhed, and the third ſentenced to pay a heavy fine.

The Athenians next laid ſiege to Megara under the conduct of Hippocrates and Demoſthenes; but Braſidas a Spartan general coming to its relief, a battle enſued, by which, though neither party got the better,

137 Spartan party prevails in Megara.

the Lacedemonian faction prevailed in Megara, and many who favoured the Athenians were forced to withdraw. After this, ſuch as had been baniſhed for adhering to the Lacedemonians were allowed to return, on their taking an oath to forget what was paſt, and attempt nothing that might diſturb their country. As ſoon as they were ſettled, however, they forgot their oath; and cauſing 100 of thoſe who were moſt obnoxious to be apprehended, forced the people to condemn them to death. They then changed the whole form of government, introduced an oligarchy, and poſſeſſed themſelves of the ſupreme power.

138 Athenians loſe their power in Bœotia.

In Bœotia ſome commotions were raiſed in favour of the Athenians; but their generals Hippocrates and Demoſthenes being defeated by the oppoſite party, all hopes ceaſed of the Athenian power being eſtabliſhed in Bœotia. In the mean time Braſidas reduced the city of Amphipolis, which greatly alarmed the Athenians,

ans, who thereupon sent new supplies of men, money, and ships to the Macedonian coast; but all their care could not prevent a great desertion from their interest in those parts, where the valour and conduct of Brasidas carried all before him.

139 Ninth year. A truce concluded and broken.

In the ninth year, the Spartans made new proposals of peace, which the Athenians were now more inclined to accept than formerly; and finding their affairs very much unsettled by the loss of Amphipolis, a truce for a year was quickly agreed on, while negociations were in the mean time carrying on for a general peace. This pacific scheme, however, was very soon overthrown by the following accident in Thrace. The city of Scione, and that of Menda, revolted to Brasidas; who, knowing nothing of the truce, sought to draw over Potidæa also. The Athenians, pretending that Scione revolted two days after the truce was concluded, made heavy complaints, asserting that this was a breach of the truce, and that both it and Menda should be restored to them. This not being effected by negociations, an army was sent against the two cities, by which Menda was reduced; but Scione making an obstinate defence, the siege was turned into a blockade.

140 Cleon defeated and killed by Brasidas.

In the tenth year, Brasidas made an attempt upon Potidæa; which having failed, the Athenians began to recover some courage. The truce expiring on the day of the Pythian games, Cleon persuaded the Athenians to send an army into Thrace under his own command. It consisted of 1200 foot and 300 horse, all Athenian citizens, who embarked on board 30 galleys. Brasidas had an army much inferior; but observing that the Athenian general was become careless, and neglected discipline, he attacked him. In this engagement Cleon was killed, and the Athenians were defeated with the loss of 600 men, while the Spartans lost only seven; but among these was their brave commander Brasidas, whose death affected them almost as much as the loss of their army did the Athenians.

141 A fifty years peace.

As the death of Cleon deprived the Athenians of one of their best speakers, and one who had been very industrious in promoting the war, they were now much more disposed than formerly to hearken to terms of accommodation. Amongst the Spartans, too, there was a party, at the head of whom was Plistonax their king, who earnestly wished for peace; and as Nicias laboured no less assiduously at Athens to bring about this desirable event, a peace was at last concluded for fifty years between the two nations. The conditions were, that a restitution of places and prisoners should be made on both sides; excepting that Nisæa should remain to the Athenians, who had taken it from the Megarians, and that Platæa should continue with the Thebans, because they absolutely would not give it up. The Bœotians, Corinthians, and Megarians, refused to be included in this peace: but the rest of the allies yielded to it; and it was accordingly ratified, receiving the name of the *Nician* peace, from Nicias who had so vigorously promoted it.

142 New discontents.

By this means, however, tranquillity was far from being restored. Such of the states of Peloponnesus as were dissatisfied, began immediately to league among themselves, and to set on foot a new confederacy, the head of which was to be the state of Argos. The Lacedemonians, too, found it impossible to perform exactly the articles of agreement; the city of Amphipolis in particular, absolutely refused to return under the Athenian government; for which reason the Athenians refused to evacuate Pylus. In the winter, new negociations were entered into on all sides, but nothing determined, and universal murmuring and discontent took place. These discontents were not a little heightened by Alcibiades, who now began to rival Nicias, and, perceiving the Lacedemonians paid their court mostly to his rival, took all opportunities to incense his countrymen against that nation. Nicias, on the other hand, who wished for nothing so much as peace, used all his endeavours to bring about a reconciliation. The artifices of Alcibiades, however, added to the turbulent and haughty disposition of both nations, rendered this impossible; so that though Nicias went on purpose to Sparta, he returned without doing any thing.

143 Heightened by Alcibiades.

144 His measures for the safety of Attica.

Alcibiades having thus disposed every thing according to his wishes, and a war being inevitable, he began to take the most prudent methods for preserving his country in safety. With this view he entered into a league for 100 years with the Argives, which he hoped would keep the war at a distance; he next passed over into the territories of Argos, at the head of a considerable army; and laboured, both at that city and at Patræ, to persuade the people to build walls to the sea, that so they might the more easily receive assistance from the Athenians. But though great preparations for war were now made, nothing was undertaken this year; only the Argives thought to have made themselves masters of Epidaurus, but were hindered by the Lacedemonians putting a garrison into it.

145 Fourteenth year. War renewed.

The next year (the 14th after the Peloponnesian war was first begun) a Spartan army, under the command of Agis, entered the territory of Argos, where the confederate army lay; but just as the engagement was about to begin, a truce was suddenly concluded by two of the Argive generals and the king of Sparta. With this neither party was pleased, and both the king and generals were very ill treated by their citizens. On the arrival of some fresh troops from Athens, therefore, the Argives immediately broke the truce; but the allied army was soon after defeated with great slaughter by Agis; notwithstanding which, however, the Eleans and Athenians invested Epidaurus. In the winter, a strong party in Argos joined the Lacedemonians; in consequence of which that city renounced her alliance with Athens, and concluded one with Sparta for 50 years. In compliment to their new allies, also, the Argives abolished democracy in their city, establishing an aristocracy in its place, and assisted the Lacedemonians with a considerable body of troops to force the Sicyonians to do the same.

146 Athenians, &c. defeated at Mantinæa.

147 Fifteenth year.

In the beginning of the 15th year, the Argives, with a levity seemingly natural to all the Greeks, renounced their alliance with Sparta, abolished aristocracy, drove all the Lacedemonians out of the city, and renewed their league with Athens. The Athenians, in the mean time, being convinced of the treachery of Perdiccas king of Macedon, renounced their alliance with him, and declared war against him.

148 Sixteenth year. Melos reduced by the Athenians.

Next year Alcibiades terminated the disputes in the city of Argos, by the banishment of the Spartan faction; after which he sailed to the island of Melos, whose inhabitants had acted with the greatest invete-

racy

Attica. racy againſt his countrymen: perceiving, however, that the reduction of the iſland would be a work of time, he left a conſiderable body of forces there, and returned to Athens. In his abſence the capital of Melos ſurrendered at diſcretion, and the inhabitants were treated with the utmoſt cruelty: all the men capable of bearing arms being ſlaughtered, and the women and children carried into captivity.

149 Seventeenth year. Athenian army in Sicily loſt, and Alcibiades flies to Sparta. In the beginning of the 17th year, Nicias was appointed commander of an expedition againſt the Syracuſans, along with Alcibiades and Lamachus as colleagues. But while the neceſſary preparations were making, all things were thrown into confuſion by the defacing of the Hermæ, or ſtatues of Mercury, of which there was a great number in the city. The authors of this ſacrilege could by no means be diſcovered, though rewards were offered for this purpoſe: at laſt the ſuſpicion fell upon Alcibiades; and for this weighty reaſon he was commanded to return from Sicily to take his trial. Alcibiades, however, knew the temper of his countrymen too well to truſt himſelf to their mercy; and therefore, inſtead of returning to Athens, he fled immediately to Sparta, where he met with a gracious reception; while the infatuated Athenians were ſeverely puniſhed by the loſs of their army, generals, and fleet, in Sicily, which the ſuperior abilities of Alcibiades would in all probability have prevented.

150 Nineteenth and twentieth years, &c. The 19th and 20th years of the war were ſpent by the Athenians in equipping a new fleet in order to repair their vaſt loſſes: but Alcibiades hurt their intereſts very much, by perſuading Tiſſaphernes the Perſian to league with the Spartans againſt them; at the ſame time he perſuaded ſeveral of the Ionian ſtates to revolt from Athens, but they were in a ſhort time obliged again to ſubmit. Notwithſtanding all theſe

151 Alcibiades flies to Perſia. ſervices, however, Alcibiades had rendered himſelf ſo hateful to Agis by debauching his wife, that he ſoon found himſelf obliged to fly to the Perſians, where Tiſſaphernes gave him a very favourable reception, and profited much by his advice, which was, to let the Greeks weaken one another by their mutual wars, and that the Perſians ought never to ſee one ſtate totally deſtroyed, but always to ſupport the weaker party.

152 Propoſes the abolition of democracy at Athens. When Tiſſaphernes had acquieſced with theſe counſels, Alcibiades privately wrote to ſome of the officers in the Athenian army at Samos, that he had been treating with the Perſians in behalf of his countrymen, but did not chooſe to return till the democracy ſhould be aboliſhed; and to incline the citizens to comply with this meaſure, he told them that the Perſian king diſliked a democracy, but would immediately aſſiſt them if that was aboliſhed, and an oligarchy erected in its ſtead.

On the arrival of Piſander and other deputies from the army, with the propoſals of Alcibiades, the Athenians without heſitation reſolved to overturn that democracy which they had all along ſo ſtrenuouſly defended. The iſſue of their preſent debate was, that Piſander with ten deputies ſhould return to Alcibiades, in order to know on what terms the king of Perſia would make an alliance with them: but that cunning Athenian having perceived that Tiſſaphernes was by no means diſpoſed to aſſiſt the Athenians on account of their having been lately ſucceſsful, he ſet up ſuch high demands in the king of Perſia's name, that the Athenians of themſelves broke off the treaty, and thus Alcibiades preſerved the friendſhip of both parties.

Piſander having engaged the army at Samos in his ſcheme of overturning democracy, that form of government was aboliſhed firſt in the cities ſubject to Athens, and laſtly in the capital itſelf. Piſander's new ſcheme was, That the old form of government ſhould be totally diſſolved: that five prytanes ſhould be elected: that theſe five ſhould chooſe 100; and that each of the hundred ſhould chooſe three: that the 400 thus elected ſhould become a ſenate with full power; but ſhould occaſionally conſult with 5000 of the moſt wealthy citizens, who ſhould thenceforward be eſteemed only *the people*; and that no authority ſhould remain with the loweſt claſs. Though the people were not very fond of this change, thoſe who conducted it, being men of great parts, found means to eſtabliſh it by force; for when the people were gone out of the city to their ordinary employments, the 400, having each a dagger concealed under his veſt, attended by a guard of 120 men, entered the ſenate-houſe, diſſolved the old ſenate, and without ceremony turned them out; after which the commons, not knowing whom to ſubmit to, or to whom to apply, made no oppoſition. 153 New form of government eſtabliſhed.

The firſt ſtep of the new governors was to deſtroy all their enemies; who, however, were not very numerous, ſo that little blood was ſhed. They next ſent ambaſſadors to Agis to ſue for peace; but he, taking for granted that the Athenians would never defend an oligarchy, gave no anſwer to the ambaſſadors, but immediately marched towards the capital with a deſign to attack it. On his arrival, however, he was quickly convinced of his miſtake, being repulſed with loſs, and obliged to retire to his old poſt.

In the mean time the Athenian army declared again for a democracy; and having recalled Alcibiades, inveſted him with full power, and inſiſted on his immediate return to Athens to reſtore the ancient government. This meaſure he refuſed to comply with, and perſuaded them to ſtay where they were, in order to ſave Ionia: he alſo prevailed on them to allow ſome deputies, who had been ſent from the new governors of Athens, to come and deliver their meſſage. To theſe deputies Alcibiades replied, that they ſhould immediately return to Athens, and acquaint the 400, that they were commanded immediately to reſign their power and reſtore the ſenate; but that the 5000 might retain theirs, provided they uſed it with moderation. 154 The army declare for a democracy, and recal Alcibiades.

By this anſwer the city was thrown into the utmoſt confuſion; but the new government party prevailing, ambaſſadors were deſpatched to Sparta with orders to procure peace on any terms. This, however, was not to be effected; and Phrynicus, the head of the embaſſy, and likewiſe of the new government party, was murdered on his return. After his death, Theramenes, the head of the other party, ſeized the chiefs of the 400; upon which a tumult enſued that had almoſt proved fatal to the city itſelf. The mob, however, being at laſt diſperſed, the 400 aſſembled, though in great fear, and ſent deputies to the people, promiſing to ſet all things to rights. In conſequence of this deputation, 155 Great confuſion at Athens.

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tion, a day was appointed for convoking a general assembly, and settling the state; but when that day came, news was brought that the Lacedemonian fleet appeared in view, and steered directly for Salamis. Thus all was again thrown into confusion; for the people, instead of deliberating on the subject proposed, ran in crowds down to the port, and perceiving the Spartans
156 Athenian fleet destroyed by the Spartans. made towards Eubœa, a fleet of 36 ships was immediately despatched under the command of Thymochares, to engage the enemy. This fleet was utterly defeated, 22 of the Athenian ships being taken, and most of the others sunk or disabled; but what was worse, this defeat was followed by the revolt of all the country of Eubœa except Orcus.

When these dismal tidings arrived at Athens, every thing was given up for lost; and had the Lacedemonians taken this opportunity of attacking the city, they had undoubtedly succeeded, and thus put an end to the war: but being at all times slow, especially in naval affairs, they gave the Athenians time to equip a new fleet, and to retrieve their affairs. One good effect of this disaster, however, was the putting an end for a time to the internal dissensions of this turbulent people; insomuch that Thucydides the historian is of opinion, that the republic never enjoyed so much quiet as at this time.

157 Exploits of Alcibiades. Alcibiades now showed his abilities and inclination to serve his country in an eminent manner. By his intrigues he so effectually embroiled the Persians and Peloponnesians with each other, that neither party knew whom to trust. Thrasybulus, with 55 ships, gained a victory over the Peloponnesian fleet consisting of 73: after which he took 8 galleys coming from Byzantium; which city had revolted from the Athenians, but was soon after taken, and the inhabitants severely fined. The fleet being afterwards joined by Alcibiades, nine more of the Peloponnesian galleys were taken, the Halicarnassians were constrained to pay a large sum of money, and Cos was strongly fortified; which transactions ended the 21st year of the Peloponnesian war.

In the succeeding years of this famous war, the Athenians had at first great advantages. Thrasybulus gained a signal victory at sea; and Alcibiades gained two victories, one by sea and another by land, in one day; took the whole Peloponnesian fleet, and more
158 The Spartans sue for peace. spoil than his men could carry away. The Spartans were now humbled in their turn, and sued for peace; but the Athenians were so intoxicated with their success, that they sent back the ambassadors without an answer: which they soon had sufficient reason to repent
159 They take Pylus. of. The beginning of the Athenian misfortunes was the taking of Pylus by the Spartans. The Athenians had sent a fleet under the command of one Anytus to its defence: but he was driven back by contrary winds; upon which he was condemned to death, because he could not cause the wind blow from what quarter he pleased: this sentence, however, was remitted on his paying a vast sum of money. This misfortune was quickly followed by another. The Megarians surprised Nysæa; which enraged the Athenians so much, that they immediately sent an army into that country, who defeated the Megarians who opposed them with great slaughter, and committed horrid devastations.

These misfortunes as yet, however, were overbalanced by the great actions of Alcibiades, Thrasybulus, and Theramenes. When Alcibiades returned, he brought with him a fleet of 200 ships, and such a load of spoils as had never been seen in Athens since the conclusion of the Persian war. The people left their city destitute, that they might crowd to the port, to behold Alcibiades as he landed; old and young blessed him as he passed; and next day when he made a harangue to the assembly, they directed the record of his banishment to be thrown into the sea, absolved him from the curses he lay under, and created him general with full power. Nor did he seem inclined to indulge himself in ease, but soon put to sea again with a fleet of 100 ships. He had not been long gone, however, before all this was forgot. Alcibiades sailed to the Hellespont with part of his fleet, leaving the rest under the command of Antiochus his pilot, but with strict orders to attempt nothing before his return. This command the pilot paid no regard to, but provoked Lysander the Lacedemonian admiral to an engagement, and in consequence of his temerity was defeated with the loss of 15 ships, himself being killed in the engagement. On the news of this defeat Alcibiades returned, and endeavoured to provoke the Lacedemonians to a second battle; but this Lysander prudently declined; and in the mean time the Athenians, with unparalleled ingratitude and inconstancy, deprived Alcibiades of his command, naming ten new generals in his room. 160 Alcibiades enters Athens in triumph. 161 He is disgraced.

This was the last step the Athenians had to take for perfecting their ruin. Conon, who succeeded to the command, was defeated by Callicratides, Lysander's successor; but being afterwards strongly reinforced, the Lacedemonians were entirely defeated with the loss of 77 ships. Such a victory might at this time have inspired the Athenians with some kind of gratitude toward the generals who granted it; but instead of this, on pretence of their not having assisted the wounded during the engagement, eight of them were recalled; two were wise enough not to return; and the six who trusted to the justice of their country were all put to death. 162 The Athenians gain a great victory and put six of their generals to death.

The next year Lysander was appointed commander of what fleet the Peloponnesians had left, with which he took Thasus and Lampsacus. Conon was despatched against him with 180 ships, which being greatly superior to Lysander's fleet, that general refused to come to an engagement, and was blocked up in the river Ægos. While the Athenians lay there, they grew quite idle and careless; insomuch that Alcibiades, who had built a castle for himself in the neighbourhood, entreated them to be more on their guard, as he well knew Lysander's abilities. They answered, that they wondered at his assurance, who was an exile and a vagabond, to come and give laws to them; telling him, that if he gave them any farther trouble, they would seize and send him to Athens. At the same time they looked on victory as so certain, that they consulted what they should do with their prisoners; which, by the advice of Philocles their general, was to cut off all their right hands, or, according to Plutarch, their right thumbs; and Adiamantus one of their officers rendered himself very obnoxious by saying, that such idle discourse did not become Athenians. The 163 They are utterly defeated by Lysander;

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consequences of such conduct may be easily imagined. Lysander fell unexpectedly upon them, and gained a most complete victory; Conon, with eight galleys only, escaping to Cyprus; after which Lysander returned to Lampsacus, where he put to death Philocles with 3000 of his soldiers, and all the officers except Adiamantus. This execution being over, he reduced all the cities subject to Athens; and with great civility sent home their garrisons, that so the city might be overstocked with inhabitants, and destitute of provisions, when he came to besiege it; which he did soon after by sea, while Agis, with a great army, invested it by land.

164 who takes Athens.

For a long time the Athenians did not so much as desire a peace; but at last were forced to send deputies to Agis, who sent them to Sparta, where no terms could be granted except they consented to demolish their walls. They next sent to Lysander, who after a long attendance referred them to Sparta; and thither Theramenes with some other deputies was immediately sent. On their arrival, they found the council of the confederates sitting, who all except the Spartans gave their votes that Athens should be utterly destroyed; but they would not consent to the ruin of that city, which had deserved so well of Greece. On the return of Theramenes, peace was concluded, on condition, that the long walls and the fortifications of the port should be demolished; that they should give up all their ships but 12, receive all they had banished, and follow the fortune of the Lacedemonians. These severe terms were punctually executed. Lysander caused the walls to be pulled down, all the music in his army playing, on that very day of the year on which they had beat the Persians at Salamis. He likewise established an oligarchy expressly against the will of the people; and thus the ruin of Athens ended the 27th year of the Peloponnesian war, and the 404th before Christ.

165 Terms of peace.

166 The thirty tyrants.

As soon as Lysander had demolished the long walls, and the fortifications of the Piræus, he constituted a council of thirty, with power, as was pretended, to make laws, but in truth to subjugate the state. These are the persons so famous in history, under the title of *the thirty tyrants*. They were all the creatures of Lysander; who, as they derived their rise from conquest and the law of the sword, exercised their offices in a suitable maner; that is, with the highest testimonies of pride, insolence, and cruelty. Instead of making laws, they governed without them; appointed a senate and magistrates at their will; and, that they might do all things without danger of controul, they sent for a garrison from Lacedemon; which was accordingly granted them, under the command of Callidius, upon their promise to pay the soldiers regularly. One of the first steps they took was to punish all informers; which, though severe, was popular: but when, through flattery and bribes, they had wholly drawn over Callidius to their party, they suffered bad men to live in quiet, and turned their rage against the good.

167 Critias and Theramenes, their opposite characters.

Critias and Theramenes were at the head of the thirty, men of the greatest power and abilities in Athens. The former was ambitious and cruel without measure; the latter was somewhat more merciful: the former pushed on all the bloody schemes framed by his confederates, and carried into execution many of his own; the latter always opposed them, at first with moderation, at last with vehemence. He said, that power was given them to rule, and not to spoil, the commonwealth; that it became them to act like shepherds, not like wolves; and that they ought to beware of rendering themselves at once odious and ridiculous, by attempting to domineer over all, being such a handful of men as they were. The rest, disliking much the former part of his discourse, catched hold of the latter, and immediately chose out 3000, whom they made the representatives of the people, and to whom they granted this notable privilege, that none of them should be put to death but by judgment of the senate, thereby openly assuming a power of putting any other of the Athenian citizens to death by their own authority. A glorious use they made of this new assumed privilege; for as many as they conjectured to be no friends to the government in general, or to any of themselves in particular, they put to death, without cause, and without mercy. Theramenes openly opposing this, and absolutely refusing to concur in such measures, Critias accused him to the senate as a man of unsteady principles, sometimes for the people, sometimes against them, always for new things and state-revolutions. Theramenes owned, that he had sometimes changed his measures, but alleged that he had always done it to serve the people. He said that it was solely with this view he made the peace with Sparta, and accepted the office of one of the thirty: that he had never opposed their measures while they cut off the wicked; but when they began to destroy men of fortune and family, then he owned he had differed with them, which he conceived to be no crime against the state.

168 Theramenes put to death.

While Theramenes was speaking, Critias withdrew, perceiving that the senate were thoroughly convinced of the truth of what Theramenes had said: but he quickly returned with a guard, crying out, that he had struck Theramenes's name out of the list of the 3000; that the senate had, therefore, no longer cognizance of the cause, when the thirty had already judged and condemned him to death. Theramenes perceiving that they intended to seize him, fled to the altar, which was in the midst of the senate-house, and laying his hands thereon, said, "I do not seek refuge here because I expect to escape death, or desire it; but that, tearing me from the altar, the impious authors of my murder may interest the gods in bringing them to speedy judgment, and thereby restore freedom to my country." The guards then dragged him from the altar, and carried him to the place of execution, where he drank the poison with undaunted courage, putting the people in mind with his last breath, that as they had struck his name out of the 3000, they might also strike out any of theirs. His death was followed by a train of murders, so that, in a short time, 60 of the worthiest and most eminent citizens of Athens fell by the cruelty of the thirty. Among these, the most pitied was Niceratus the son of Nicias; a man universally beloved for his goodness, and universally admired for his virtues. As for the Spartans, they, losing their former generosity, were extremely pleased with these things, and, by a public decree, commanded that such as fled from the thirty tyrants should be carried back bound to Athens: which extraordinary proceeding frightened all Greece; but the Argives and Thebans only had courage

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courage to oppoſe it: the former received the Athenian exiles with humanity and kindneſs; the latter puniſhed with a mulct ſuch of their citizens as did not riſe and reſcue the Athenian priſoners, who in purſuance of the Lacedemonian decree were carried bound through their territories.

Thraſybulus, and ſuch as with him had taken ſhelter in the Theban territory, reſolved to hazard every thing, rather than remain perpetual exiles from their country; and though he had but 30 men on whom he could depend, yet conſidering the victories he had heretofore obtained in the cauſe of his country, he made an irruption
169 Thraſybulus ſeizes Phyla.
into Attica, where he ſeized Phyla, a caſtle at a very ſmall diſtance from Athens, where in a very ſhort ſpace his forces were augmented to 700 men; and though the tyrants made uſe of the Spartan garriſon in their endeavours to reduce him and his party, yet Thraſybulus prevailed in various ſkirmiſhes, and at laſt obliged them to break up the blockade of Phyla, which they had formed. The thirty and their party conceiving it very advantageous for them to have the poſſeſſion of Eleuſina, marched thither, and having perſuaded the people to go unarmed out of their city, that they might number them, took this opportunity moſt inhumanly to murder them. The forces of Thraſybulus increaſing daily, he at length poſſeſſed himſelf of the Piræus, which he fortified in the beſt manner he could; but the tyrants being determined to drive him from thence, came down againſt him with the utmoſt force they could raiſe. Thraſybulus defended himſelf with great obſtinacy; and in the end they were forced to
170 Critias killed.
retreat, having loſt before the place not only a great number of their men, but Critias the preſident of the thirty, another of the ſame body, and one who had been a captain of the Piræus.

When they came to demand the dead from Thraſybulus, in order for their interment, he cauſed a crier he had with him to make a ſhort ſpeech in a very loud voice to the people, entreating them to conſider, that as they were citizens of Athens without, ſo thoſe againſt whom they fought, and thoſe who ſought to preſerve themſelves within the fort, were Athenian citizens alſo; wherefore, inſtead of thinking how to ruin and deſtroy their brethren, they ought rather to conſult how all differences might be compoſed, and eſpecially ought to rid themſelves of thoſe bloody tyrants, who, in the ſhort time they had had the adminiſtration in their hands, had deſtroyed more than had fallen in the Peloponneſian war. The people, though moved by theſe diſ-
171 The tyrants expelled.
courſes, differed among themſelves; the conſequence of which was, that they expelled the thirty, and choſe ten men out of each tribe to govern in their ſtead, whereupon the tyrants retired to Eleuſina. The citizens, however, though they changed the government, made no agreement with thoſe in the Piræus; but ſent away deputies to Sparta, as did alſo the tyrants from Eleuſina, complaining, that the Athenians had revolted, and deſiring their aſſiſtance to reduce them. The Spar-
172 Attempt of the Spartans to reduce Athens a ſecond time.
tans ſent thereupon a large ſum of money to encourage their confederates, and appointed Lyſander commander in chief, and his brother to be admiral; reſolving to ſend ſea and land forces to reduce Athens a ſecond time; intending, as moſt of the Greek ſtates ſuſpected, to add it now to their own dominions. It is very probable that this deſign of theirs would have taken effect, if Pauſanias king of Sparta, envying Lyſander, had not reſolved to obſtruct it. With this view, he procured another army to be raiſed againſt the Athenians, of which himſelf had the command, and with which he marched immediately to beſiege the Piræus. While he lay before the place, and pretended to attack it, he entered into a private correſpondence with Thraſybulus, informing him what propoſitions he ſhould make in order to force the Lacedemonians, who were ſuſpected by their allies, to grant them peace.

173 How fruſtrated.
The intrigues of Pauſanias had all the ſucceſs he could wiſh. The Ephori who were with him in the camp concurred in his meaſures, ſo that in a ſhort ſpace a treaty was concluded on the following terms: That all the citizens of Athens ſhould be reſtored to their houſes and privileges, excepting the thirty, the ten which had ſucceeded them and who had acted no leſs tyrannically than they, and the eleven who during the time of the oligarchy had been conſtituted governors or keepers of the Piræus; that all ſhould remain quiet for the future in the city; and that if any were afraid to truſt to this agreement, they ſhould have free leave to retire to Eleuſina. Pauſanias then marched away with the Spartan army, and Thraſybulus at the head of his forces marched into Athens, where having laid down their arms, they ſacrificed with the reſt of the citizens in the temple of Minerva, after which the popular government was reſtored. Yet quiet was not thoroughly eſtabliſhed. The exiles at Eleuſina having endeavoured by the help of money to raiſe an army of foreigners, by whoſe aid they might recover the authority they had loſt: but firſt depending on their friends in the city, they ſent ſome of the principal perſons amongſt them as deputies, to treat with the citizens; but ſtrictly inſtructed them to ſow jealouſies and excite diſcords among them. This the latter quickly perceiving, put theſe perſons to death; and then remonſtrating to thoſe at Eleuſina, that theſe contentions would undoubtedly end either in their own or the deſtruction of their country, they offered immediately to paſs an act of oblivion, which they would confirm with an oath.

This being accepted, thoſe who had withdrawn returned to the city, where all differences were adjuſted, and both parties moſt religiouſly obſerved the agreement they had made, and thereby thoroughly reſettled the ſtate. In this whole tranſaction, the virtue of Thra- 174 Virtue of Thraſybulus.
ſybulus deſerves chiefly to be admired. When he firſt ſeized the caſtle of Phyla, the tyrants privately offered to receive him into their number inſtead of Theramenes, and to pardon at his requeſt any 12 perſons he ſhould name: but he generouſly anſwered, That his exile was far more honourable than any authority could be, purchaſed on ſuch terms; and by perſiſting in his deſign, accompliſhed, as we have ſeen, the deliverance of his country. A glorious deliverance it was; ſince, as Iſocrates informs us, they had put 1400 citizens to death contrary to and without any form of law, and driven 5000 more into baniſhment; procuring alſo the death of Alcibiades, as many think, though at a great diſtance from them.

From this time to the reign of Philip of Macedon, the Athenians continued in a pretty proſperous ſituation, though they never performed any ſuch great exploits as

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as formerly. By that monarch and his ſon Alexander all Greece was in effect ſubdued, and the hiſtory of all the Grecian ſtates from that time becomes much leſs intereſting. Of the hiſtory of Athens from that time to the preſent, the following elegant abridgment is given by Dr Chandler*. "On the death of Alexander, the Athenians revolted, but were defeated by Antipater, who garriſoned Munychia.

175 Hiſtory of Athens from the time of Alexander the Great to the preſent.

They rebelled again, but the garriſon and oligarchy were reinſtated. Demetrius the Phalerean, who was made governor, beautified the city, and they erected to him 360 ſtatues; which on his expulſion they demoliſhed, except one in the Acropolis. Demetrius Poliocertes withdrew the garriſon, and reſtored the democracy; when they deified him, and lodged him in the Opiſthodomos or the back part of the Parthenon, as a gueſt to be entertained by their goddeſs Minerva. Afterwards they decreed, that the Piræus, with Munychia, ſhould be at his diſpoſal; and he took the Muſeum. They expelled his garriſon, and he was perſuaded by Craterus a philoſopher to leave them free. Antigonus Gonatas, the next king, maintained a garriſon in Athens: but on the death of his ſon Demetrius, the people, with the aſſiſtance of Aratus, regained their liberty; and the Piræus, Munychia, Salamis, and Sunium, on paying a ſum of money.

* *Travels into Greece*, p. 28, &c.

"Philip, ſon of Demetrius, encamping near the city, deſtroying and burning the ſepulchres and temples in the villages, and laying their territory waſte, the Athenians were reduced to ſolicit protection from the Romans, and to receive a garriſon, which remained until the war with Mithridates king of Pontus, when the tyrant Ariſtion made them revolt.

176 Athens beſieged and taken by Sylla.

"Archelaus the Athenian general, unable to withſtand the Roman fury, relinquiſhed the *long walls*, and retreated into the Piræus and Munychia. Sylla laid ſiege to the Piræus and to the city, in which Ariſtion commanded. He was informed that ſome perſons had been overheard taking in the Ceramicus, and blaming Ariſtion for his neglect of the avenues about the Heptachalcos, where the wall was acceſſible. Sylla reſolved to ſtorm there, and about midnight entered the town at the gate called *Dypylon* or *the Piræan;* having levelled all obſtacles in the way between it and the gate of the Piræus. Ariſtion fled to the Acropolis, but was compelled to ſurrender by the want of water; when he was dragged from the temple of Minerva, and put to death. Sylla burned the Piræus and Munychia, and defaced the city and ſuburbs, not ſparing even the ſepulchres.

"The civil war between Cæſar and Pompey ſoon followed, and their natural love of liberty made them ſide with Pompey. Here again they were unfortunate, for Cæſar conquered. But Cæſar did not treat them like Sylla. With that clemency which made ſo amiable part of his character, he diſmiſſed them by a fine alluſion to their illuſtrious anceſtors, ſaying, that he ſpared the living for the ſake of the dead.

"Another ſtorm followed ſoon after this; the wars of Brutus and Caſſius with Auguſtus and Antony. Their partiality for liberty did not here forſake them: they took part in the conteſt with the two patriot Romans, and erected their ſtatues near their own ancient deliverers Harmodius and Ariſtogiton, who had ſlain Hipparchus. But they were ſtill unhappy, for their enemies triumphed.

"They next joined Antony, who gave them Ægina and Cea, with other iſlands. Auguſtus was unkind to them; and they revolted four years before he died. Under Tiberius the city was declining, but free, and regarded as an ally of the Romans. The high priviledge of having a lictor to precede the magiſtrates was conferred on it by Germanicus; but he was cenſured as treating with too much condeſcenſion a mixture of nations, inſtead of genuine Athenians, which race was then conſidered as extinct.

"The emperor Veſpaſian reduced Achaia to a province paying tribute and governed by a proconſul. Nerva was more propitious to the Athenians; and Pliny, under Trajan his ſucceſſor, exhorts Maximus to be mindful whither he was ſent, to rule genuine Greece, a ſtate compoſed of free cities. 'You will revere the gods and heroes their founders. You will reſpect their priſtine glory, and even their age. You will honour them for the famous deeds, which are truly, nay for thoſe which are fabulouſly, recorded of them. Remember, it is Athens you approach.' This city was now entirely dependent on Rome, and was reduced to ſell Delos and the iſlands in its poſſeſſion.

"Hadrian, who was at once emperor and an archon of Athens, gave the city laws, compiled from Draco, Solon, and the codes of other legiſlators; and diſplayed his affection for it by unbounded liberality. Athens reflouriſhed, and its beauty was renewed. Antoninus Pius who ſucceeded, and Antoninus the philoſopher, were both benefactors.

"The barbarians of the north, in the reign of Valerian, beſieging Theſſalonica, all Greece was terrified, and the Athenians reſtored their city-wall, which had been diſmantled by Sylla, and afterwards neglected.

"Under the next emperor, who was the archon Gallienus, Athens was beſieged, the archontic office ceaſed; and the ſtrategus or general, who had before acted as overſeer of the agora or market, then became the ſupreme magiſtrate. Under Claudius his ſucceſſor, the city was taken, but ſoon recovered.

"It is related, that Conſtantine, when emperor, gloried in the title of *general of Athens;* and rejoiced exceedingly on obtaining from the people the honour of a ſtatue with an inſcription, which he acknowledged by a yearly gratuity of many buſhels of grain. He conferred on the governor of Attica and Athens the title of *grand duke*, μεγας δουξ. That office was at firſt annual, but afterwards hereditary. His ſon Conſtans beſtowed ſeveral iſlands on the city, to ſupply it with corn.

"In the time of Theodoſius I. 380 years after Chriſt, the Goths laid waſte Theſſaly and Epirus; but Theodore, general of the Achæans, by his prudent conduct preſerved the cities of Greece from pillage, and the inhabitants from being led into captivity. A ſtatue of marble was erected to him at Athens by order of the city; and afterwards one of braſs, by command of the emperor, as appears from an inſcription in a church dedicated to a ſaint of the ſame name, not far from the French convent. It is on a round pedeſtal, which ſupports a flat ſtone ſerving for the holy table. Eudocia the wife of Theodoſius II. was an Athenian.

177 By Alaric the Goth.

"The fatal period now approached, and Athens was about to experience a conqueror more ſavage even than

than Sylla. This was Alaric king of the Goths; who, under the emperors Arcadius and Honorius, overran Greece and Italy, ſacking, pillaging, and deſtroying. Then the Peloponneſian towns were overturned, Arcadia and Lacedemon were laid waſte, the two ſeas by the iſthmus were burniſhed with the flames of Corinth, and the Athenian matrons were dragged in chains by barbarians. The invaluable treaſures of antiquity, it is related, were removed; the ſtately and magnificent ſtructures converted into piles of ruin; and Athens was ſtripped of every thing ſplendid or remarkable. Syneſius, a writer of that age, compares the city to a victim, of which the body had been conſumed, and the hide only remained.

" After this event, Athens became an unimportant place, and as obſcure as it once had been famous. We read that the cities of Hellas were put into a ſtate of defence by Juſtinian, who repaired the walls, which at Corinth had been ſubverted by an earthquake, and at Athens and in Bœotia were impaired by age; and here we take a long farewel of this city. A chaſm of near 700 years enſues in its hiſtory, except that, about the year 1130, it furniſhed Roger the firſt king of Sicily with a number of artificers, whom he ſettled at Palermo, where they introduced the culture of ſilk, which then paſſed into Italy. The worms had been brought from India to Conſtantinople in the reign of Juſtinian.

" Athens, as it were, re-emerges from oblivion in the 13th century, under Baldwin, but beſieged by a general of Theodorus Laſcaris, the Greek emperor. It was taken in 1427 by Sultan Morat. Boniface, marquis of Montferrat, poſſeſſed it with a garriſon; after whom it was governed by Delves, of the houſe of Arragon. On his death it was ſeized, with Macedonia, Theſſaly, Bœotia, Phocis, and the Peloponneſus, by Bajazet; and then, with the iſland Zante, by the Spaniards of Catalonia in the reign of the Greek emperor Andronicus Palæologus the elder. Theſe were diſpoſſeſſed by Reinerius Acciaioli, a Florentine; who, leaving no legitimate male iſſue, bequeathed it to the ſtate of Venice. His natural ſon, Antony, to whom he had given Thebes with Bœotia, expelled the Venetians. He was ſucceeded in the dukedom by his kinſman Nerius, who was diſplaced by his own brother named *Antony*, but recovered the government when he died. Nerius, leaving only an infant ſon, was ſucceeded by his wife. She was ejected by Mahomet on a complaint from Francus

178 By the Turks. ſon of the ſecond Antony, who confined her at Megara, and made away with her; but her ſon accuſing him to Mahomet the Second, the Turkiſh army under Omar advanced, and he ſurrendered the citadel in 1455; the Latins refuſing to ſuccour him unleſs the Athenians would embrace their religious tenets. Mahomet, it is related, when he had finiſhed the war with the deſpot of the Morea, four years after, ſurveyed the city and Acropolis with admiration. The janizaries informed him of a conſpiracy; and Francus Acciaioli, who remained lord of Bœotia, was put to death. In 1464 the Venetians landed at the Piræus, ſurpriſed the city, and carried off their plunder and captives to Eubœa.

" It is remarkable, that after theſe events Athens was again in a manner forgotten. So lately as about the middle of the 16th century, the city was commonly believed to have been utterly deſtroyed, and not to exiſt, except a few huts of poor fiſhermen. Cruſius, a learned and inquiſitive German, procured more authentic information from his Greek correſpondents reſiding in Turkey, which he publiſhed in 1584, to awaken curioſity and to promote farther diſcoveries. One of theſe letters is from a native of Nauplia, a town near Argos in the Morea. This writer ſays that he had been often at Athens, and that it ſtill contained many things worthy to be ſeen, ſome of which he enumerates, and then ſubjoins; " But why do I dwell on this place? It is as the ſkin of an animal which has been long dead."

It now remains to give ſome idea of the character, government, and religion of this once ſo famous people.

The Athenians, ſays Plutarch, are very ſubject to violent anger; but they are ſoon pacified. They are likewiſe eaſily impreſſed with humanity and compaſſion. 179 Character of the ancient Athenians.

That this was their temper, is proved by many hiſtorical examples. We ſhall produce a few. The ſentence of death pronounced againſt the inhabitants of Mitylene, and revoked the next day: The condemnation of Socrates, and that of the ten chiefs, each followed by quick repentance and moſt pungent grief.

The minds of the ſame people, adds Plutarch, are not formed for laborious reſearches. They ſeize a ſubject, as it were, by intuition; they have not patience and phlegm enough to examine it gradually and minutely. This part of their character may ſeem ſurpriſing and incredible. Artiſans, and other people of their rank, are in general ſlow of comprehenſion. But the Athenians of every degree were endowed with an inconceivable vivacity, penetration, and delicacy of taſte. Even the Athenian ſoldiers could repeat the fine paſſages of the tragedies of Euripides. Thoſe artiſans and thoſe ſoldiers aſſiſted at public debates, were bred to political affairs, and were equally acute in apprehenſion and in judgment. We may infer the underſtanding of the hearers of Demoſthenes from the genius of his orations, which were laconic and poignant.

As their inclination, continues Plutarch, leads them to aſſiſt and ſupport people of low condition, they like diſcourſe ſeaſoned with pleaſantry, and productive of mirth. The Athenians patronize people of low degree; becauſe from them their liberty is in no danger, and becauſe ſuch patronage tends to ſupport a democratical conſtitution. They love pleaſantry; which turn of mind proves that they are a humane ſocial people, who have a taſte for raillery and wit, and are not ſoured with that reſerve which marks the deſpot or the ſlave.

They take pleaſure in hearing themſelves praiſed; but they can likewiſe patiently bear raillery and cenſure. We know with what art and ſucceſs Ariſtophanes and Demoſthenes applied their praiſe and their irony to the Athenian people. When the republic enjoyed peace, ſays the ſame Plutarch in another place, it encouraged the adulation of its orators: but when it had important affairs to diſcuſs, when the ſtate was in danger, it became ſerious; and preferred to its eloquent ſycophants, the honeſt orators who oppoſed its follies and its vices; ſuch ingenious and bold patriots as a Pericles, a Phocion, and a Demoſthenes.

The Athenians, continues Plutarch, often make their governors tremble, and ſhow great humanity to their

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their enemies. They were very attentive to the information and inſtruction of thoſe citizens who were moſt eminent for their policy and eloquence; but they were on their guard againſt the ſuperiority of their talents; they often checked their boldneſs, and repreſſed their exuberant reputation and glory. That this was their temper, we are convinced by the oſtraciſm: which was eſtabliſhed to reſtrain the ambition of thoſe who had great talents and influence, and which ſpared neither the greateſt nor the beſt men. The deteſtation of tyranny and of tyrants, which was inherent in the Athenians, rendered them extremely jealous of their privileges, made them zealous and active in defence of their liberty, whenever they thought it was violated by men in power.

As to their enemies, they did not treat them with rigour. They did not abuſe victory by a brutal inhumanity to the vanquiſhed. The act of amneſty, which they paſſed after the uſurpation of the 30 tyrants, proves that they could eaſily forgive injuries. It was this mildneſs, this humanity of diſpoſition, which made the Athenians ſo attentive to the rules of politeneſs and decorum. In their war with Philip, having ſeized one of his couriers, they read all the letters he bore, except one from Olympias to her huſband, which they ſent back unopened. Such was their veneration of love and conjugal ſecrecy; thoſe ſacred rights, which no emnity, no hoſtility, warrants us to violate!

The views of conqueſt cheriſhed by a ſmall republic, were extenſive and aſtoniſhing; but this people, ſo great, ſo ambitious in their projects, were, in other reſpects, of a different character. In the expences of the table, in dreſs, in furniture, in houſes, in ſhort, in private life, they were frugal, ſimple, modeſt, poor; but ſumptuous and magnificent whenever the honour of the ſtate was concerned. Their conqueſts, their victories, their riches, their connections with the inhabitants of Aſia Minor, never reduced them to luxury, to riot, to pomp, to profuſion. Xenophon remarks, that a citizen was not diſtinguiſhed from a ſlave by his dreſs. The wealthieſt citizen, the moſt renowned general, was not aſhamed to go himſelf to market.

The taſte of the Athenians, for all the arts and ſciences, is well known. When they had delivered themſelves from the tyranny of Piſiſtratus, and after this had defeated the vaſt efforts of the Perſians, they may be conſidered as at the ſummit of their national glory. For more than half a century afterwards they maintained, without controul, the ſovereignty of Greece; and that aſcendant produced a ſecurity, which left their minds at eaſe, and gave them leiſure to cultivate every thing liberal or elegant. It was then that Pericles adorned the city with temples, theatres, and other beautiful public buildings. Phidias, the great ſculptor, was employed as his architect, who, when he had erected edifices, adorned them himſelf, and added ſtatues and baſſo-relievos, the admiration of every beholder. It was then that Polignotus and Myro painted; that Sophocles and Euripides wrote; and not long after, that they ſaw the divine Socrates.

Human affairs are, by nature, prone to change; and ſtates, as well as individuals, are born to decay. Jealouſy and ambition inſenſibly fomented wars, and ſucceſs in theſe wars, as in others, was often various. The military ſtrength of the Athenians was firſt impaired by the Lacedemonians; after that it was again humiliated, under Epaminondas, by the Thebans: and laſt of all it was wholly cruſhed by the Macedonian, Philip.

Nor, when their political ſovereignty was loſt, did their love of literature and the arts ſink along with it. Juſt at the cloſe of their golden days of empire flouriſhed Xenophon and Plato, the diſciples of Socrates, and from Plato deſcended that race of philoſophers called the *Old Academy*. Ariſtotle, who was Plato's diſciple, may be ſaid not to have invented a new philoſophy, but rather to have tempered the ſublime and rapturous myſteries of his maſter with method, order, and a ſtricter mode of reaſoning. Zeno, who was himſelf alſo educated in the principles of Platoniſm, only differed from Plato in the comparative eſtimate of things, allowing nothing to be intrinſically good but virtue, nothing intrinſically bad but vice, and conſidering all other things to be in themſelves indifferent. He too and Ariſtotle accurately cultivated logic, but in different ways; for Ariſtotle chiefly dwelt upon the ſimple ſyllogiſm; Zeno upon that which is derived out of it, the compound or hypothetic. Both too, as well as other philoſophers, cultivated rhetoric along with logic; holding a knowledge in both to be requiſite for thoſe who think of addreſſing mankind with all the efficacy of perſuaſion. Zeno elegantly illuſtrated the force of theſe two powers by a ſimile taken from the hand: the cloſe power of logic he compared to the fiſt, or hand compreſt; the diffuſe power of logic, to the palm, or hand open.

The new academy was founded by Arceſilas, and ably maintained by Carneades. From a miſtaken imitation of the great parent of philoſophy Socrates (particularly as he appears in the dialogues of Plato), becauſe Socrates doubted ſome things, therefore Arceſilas and Carneades doubted all.—Epicurus drew from another ſource; Democritus had taught him atoms and a void: by the fortuitous concourſe of atoms he fancied he could form a world; while by a feigned veneration he complimented away his gods, and totally denied their providential care, leſt the trouble of it ſhould impair their uninterrupted ſtate of bliſs. Virtue he recommended, though not for the ſake of virtue, but pleaſure; pleaſure, according to him, being our chief and ſovereign good. See Aristotle, Epicurus, Plato, Socrates, &c.

We have already mentioned the alliance between philoſophy and rhetoric. This cannot be thought wonderful, if rhetoric be the art by which men are perſuaded, and if men cannot be perſuaded without a knowledge of human nature: for what but philoſophy can procure us this knowledge? It was for this reaſon the ableſt Greek philoſophers not only taught, but wrote alſo treatiſes upon rhetoric. They had a farther inducement, and that was the intrinſic beauty of their language as it was then ſpoken among the learned and polite. They would have been aſhamed to have delivered philoſophy, as it has been too often delivered ſince, in compoſitions as clumſy as the common dialect of the mere vulgar.

The ſame love of elegance, which made them attend to their ſtyle, made them attend even to the places

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ces where their philosophy was taught. Plato delivered his lectures in a place shaded with groves, on the banks of the river Ilissus; and which, as it once belonged to a person called *Academus*, was called after his name, the ACADEMY. Aristotle chose another spot of a similar character, where there were trees and shade; a spot called the LYCEUM. Zeno taught in a portico or colonnade, distinguished from other buildings of that sort (of which the Athenians had many) by the name of the *Variegated Portico*, the walls being decorated with various paintings of Polygnotus and Myro, two capital masters of that transcendent period. Epicurus addressed his hearers in those well known gardens, called, after his own name, *The gardens of Epicurus*.

These places of public institution were called among the Greeks by the name of *Gymnasia*; in which, whatever that word might have originally meant, were taught all those exercises, and all those arts, which tended to cultivate not only the body but the mind. As man was a being consisting of both, the Greeks could not consider that education as complete, in which both were not regarded, and both properly formed. Hence their Gymnasia, with reference to this double end, were adorned with two statues, those of Mercury and of Hercules, the corporeal accomplishments being patronized (as they supposed) by the god of strength, the mental accomplishments by the god of ingenuity.

It was for the cultivation of every liberal accomplishment that Athens was celebrated (as we have said) during many centuries, long after her political influence was lost and at an end.

She was the place of education, not only for Greeks but for Romans. It was hither that Horace was sent by his father; it was here that Cicero put his son Marcus under Cratippus, one of the ablest philosophers then belonging to that city.—The sects of philosophers which we have already described, were still existing when St Paul came thither. We cannot enough admire the superior eloquence of that apostle, in his manner of addressing so intelligent an audience. We cannot enough admire the sublimity of his exordium; the propriety of his mentioning an altar which he had found there; and his quotation from Aratus, one of their well known poets. Nor was Athens only celebrated for the residence of philosophers, and the institution of youth: men of rank and fortune found pleasure in a retreat, which contributed so much to their liberal enjoyment.

We shall finish this picture of the Athenians by the addition of one object more, to which every one will admit they have a right; an object which was prominent and striking, in all their actions and in all their enterprises: We mean their ardent love of liberty. This was their predominant quality; the main spring of their government. From the beginning of the Persian war, they sacrificed every thing to the liberty of Greece. They left, without hesitation, their cities, their houses, to fight at sea the common enemy, from whom they were in danger of servitude. What a glorious day was it for Athens, when all her allies, growing flexible to the advantageous offers which were made to them by the king of Persia, she replied by Aristides, to the ambassadors of that monarch,—"That it was impossible for all the gold in the world to tempt the republic of Athens: to prevail with her to sell her liberty, and that of Greece." It was by these generous sentiments that the Athenians not only became the bulwark of Greece, but likewise guarded the rest of Europe from a Persian invasion.

These great qualities were blended with great failings, seemingly incompatible with patriotism. For the Athenians, notwithstanding their tenacious jealousy of the rights of their country, were a volatile, inconstant, capricious people.

180 Religion.

There never was a people more attentive to the worship of the gods than the Athenians. The worship of their principal deities was diffused over all Greece, and even beyond its limits.

Each temple had its particular religious rites: the pomp, the ceremonies, the duration, and the succession of the solemn feasts were all appointed by fixed rules. The worship paid to each divinity, whether public or private, was founded on traditions, or on laws constantly obeyed. The feast of Bacchus, the Panathenæa, the feast of the mysteries of Eleusis, were celebrated according to established rules, most of which were as ancient as the feasts themselves. The old customs, of which the priests were the guardians, were observed in the temples. It is probable that the priests were consulted on affairs in which the worship of a deity was interested, and that their answer was decisive. We are certain that the Eumolpidæ had this authority. They were the interpreters of the ancient laws on which the worship of Ceres was founded, its magnificence, and its mode—laws which were not written, as Lysias informs us, but were perpetuated by a constant observation. The abuses which had gradually crept into the celebration of those feasts, had given rise to several new regulations; to that of the orator Lycurgus, for example, and to the law of Solon, which enjoined the senate to repair to Eleusis on the second day of the feast: but neither these, nor the other particular regulations which we find in Samuel Petit's collection of Attic laws, could make a religious code. There was no general system which comprehended all the branches of their religion, which, by combining all its articles, might regulate their belief and conduct, and direct the judges in their decisions.

181 Crimes against religion why sometimes punished with severity.

Crimes against religion were only punished as they affected the state; and consequently they were tried by the magistrate. Mere raillery, though somewhat profane, was thought productive of no worse consequence than offending the ministers of the gods. The Athenians acknowledged no other religion than the hereditary public worship; no other gods than those they had received from their ancestors; no other ceremonies than those which had been established by the laws of the state, and practised by their country from time immemorial. They were only solicitous to preserve this worship, which was closely interwoven with their government, and made a part of its policy. They were likewise attentive to the ceremonial pomp; because order, the regular vigour of legislation, depends greatly on the awe impressed by externals. But as to the inconsistent and monstrous romance of fable, foreign opinions, popular traditions, and poetical fictions, which formed a religion quite different from that of the state—in it they were very little interested, and allowed every one to think of it as he pleased.

This explanation will reconcile a seeming contradiction

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tion in the conduct of the Athenians, who gave great licenſe to their poets, and ſeverely puniſhed the citizens who were guilty of impiety. Ariſtophanes, who made as free with the gods as with the great, was applauded by the Athenians. They condemned Socrates to death, who revered the Deity, but diſapproved the public manner of worſhipping him. The life of Æſchylus was in danger from a ſuſpicion that he had revealed ſome of the ſecrets of Eleuſis in one of his pieces. The wit of Ariſtophanes's drama was unpuniſhed.

182
Prieſts, their duty.

The prieſts were not confined to the care of the altars; they who were veſted with the ſacerdotal dignity, which was only incompatible with profeſſions merely uſeful and lucrative, might likewiſe hold the moſt important offices of the commonwealth. This we could prove by a great number of examples; we ſhall cite that of Xenophon the illuſtrious hiſtorian and philoſopher: he was likewiſe a famous general, and he was a prieſt. He was performing the ſacerdotal function when he received the news of his ſon's death, who was killed at the battle of Mantinea.

The ſacred miniſtry was not only compatible with civil offices, but likewiſe with the profeſſion of arms. The prieſt and the ſoldier were often blended. Callias, the prieſt of Ceres, fought at Platæa. This cuſtom was not peculiar to the Athenians. The Lacedemonians, after the battle which we have juſt mentioned, made three graves for their ſlain; one for the prieſts, one for the other Spartans, and one for the Helots.

183
Sacred revenues, &c.

As the ordinary buſineſs of life was incompatible with the ſacerdotal dignity, the prieſts had a revenue fixed to their office. We know that a part of the victims was their right, and that apartments were aſſigned them near the temples. But, beſide theſe advantages, they had a ſalary proportioned to the dignity of their functions and to the rank of the deities whom they ſerved. Their ſalary was probably paid from the revenue of the temples. Thoſe revenues, which kept the temples in repair, and defrayed the ſacrificial expences, were very conſiderable. They were of many different kinds.

A great part of the ſacred revenues aroſe from fines, which individuals were condemned to pay for various offences; fines, of which the tenth part was appropriated to Minerva Polias, and the fiftieth to the other gods, and to the heroes whoſe names their tribes bore. Beſides, if the Prytanes did not hold the aſſemblies conformably with the laws, they were obliged to pay a fine of 1000 drachms to the goddeſs. If the Proedri, *i. e.* the ſenators whoſe office it was to lay before the aſſembly the matters on which they were to deliberate, did not diſcharge that duty according to the rules preſcribed to them, they were likewiſe condemned to pay a fine, which, as the former, was applied to the uſe of Minerva. By theſe fines her temple muſt have been greatly enriched.

Beſides this revenue, which was the common property of the gods, and which varied according to the number and degrees of the miſdemeanours, the temples had their permanent revenues: We mean the produce of the lands which were conſecrated to the deities. We do not here allude to the lands conſecrated to the gods, which were never to be cultivated; ſuch as the territory of Cirrha, proſcribed by a ſolemn decree of the Amphictyons; the land betwixt Megara and Attica, which was conſecrated to the goddeſſes of Eleuſis, and many others. We would ſpeak only of thoſe which were cultivated, the fruits of which enriched the temples.

There were likewiſe lands belonging to the ſtate, the produce of which was deſtined to defray the expence of the ſacrifices which were offered in the name of the republic. There were likewiſe firſt-fruits which the public officers levied on all lands, for the uſe of the gods. All theſe emoluments made a part of the revenue of the temples.

The gods, beſides the revenues immediately appertaining to their temples, had certain rights which were granted them by particular compact. The Lepreatæ, for inſtance, were obliged to pay every year a talent to Olympian Jupiter, on account of a treaty of alliance which they made with the Eleans in one of their wars. The inhabitants of Epidaurus, to obtain leave from the Athenians to cut down olive-trees for ſtatues, which the Pythian prieſteſs had commanded them to make, engaged to ſend deputies every year to Athens, to offer ſacrifices in their name to Minerva and to Neptune. But this prerogative was rather honorary than lucrative.

The tenth part of the ſpoils taken in war was likewiſe the property of Minerva. Sacred veſſels were bought with the effects of the 30 tyrants. In ſhort, the gods were profited by almoſt every public accident. But what contributed moſt to enrich the famous temples of Greece, was the money which was conſtantly brought to them by individuals, in conſequence of vows they had made, or to pay for ſacrifices which were offered in their names. The credulity of the people was an inexhauſtible fund. That credulity enriched the temples of Delos and Eleuſis, and ſupported the magnificence of Delphi. And thoſe immenſe treaſures which were the fruit of ſuperſtition, were often a prey to avarice.

Theſe revenues were not depoſited with the prieſts; nor did they expend them. A moderate ſalary was all their gain; and to offer ſacrifices to the deities whoſe miniſters they were, was all their employment.

It is very probable that all the ſacred revenues were paid into the hands of officers who were appointed to receive them, and who were to give an account of the diſcharge of their truſt. Nay, we cannot doubt of this, after reading a paſſage in Ariſtotle, who, ſpeaking of the officers of the temples, expreſly mentions thoſe who are intruſted with the money appertaining to the gods. Citizens, without doubt, of approved integrity, were choſen to this office; and their duty muſt have been, to keep the temples in repair and order, and to diſburſe and keep an account of the ordinary ſacred expences.

As to the ſolemn feaſts, which were incredibly magnificent, ſuch as the feaſt of Bacchus, and the Panathenæa, they were celebrated at the expence of the choregus; *i. e.* of the chief of the choir of each tribe; for each tribe had its poet and its muſicians, who ſung, emulating each other, hymns in honour of the deity. The richeſt citizens were appointed chiefs of the different choirs; and as their office was very expenſive, to indemnify them in ſome degree, the choregus of the

the victorious tribe had the privilege of engraving his name on the tripod which that tribe ſuſpended to the roof of the temple. This office, though ruinous, was eagerly ſolicited; and naturally, in a republican ſtate. It led to honours, like the curule dignity at Rome; and it greatly tended to ingratiate its poſſeſſor with a people who were more affected with pleaſures than with eſſential ſervices, and who, conſequently, would more highly eſteem a profuſe choregus than a victorious general.

With regard to the fines, which were in the whole, or in part, the property of Minerva and of the other deities, there were at Athens public treaſurers appointed to receive them. They were ten in number, and they were nominated by lot. They were called *Treaſurers of the goddeſs*, or *Receivers of the ſacred money*. That money they received in the preſence of the ſenate; and they were empowered to diminiſh or to annihilate the fine, if they thought it unjuſt. The ſtatue of Minerva, that of the Victories, and the other invaluable pledges of the duration of the ſtate, were depoſited with them.

The treaſury in which the money conſecrated to the gods was kept, was in the citadel, behind the temple of Minerva Polias; and from its ſituation it was termed *Opiſtodomus*. It was ſurrounded with a double wall. It had but one door, the key of which was kept by the Epiſtates, or chief of the Prytanes: his dignity was very conſiderable; but it laſted only one day. In this treaſury a regiſter was kept, in which were written the names of all thoſe who were indebted to the ſtate; he who owed the ſmalleſt fine was not omitted. If the debtors proved inſolvent, they were proſecuted with extreme rigour, and often puniſhed with a cruelty which religion could not excuſe; though the intereſt of the gods was the motive, or rather the pretext. The ſacred treaſurers held a conſiderable rank among the magiſtrates who received the public finances. Of theſe magiſtrates there were many kinds, as there were many ſorts of revenues.

The Athenian prieſts did not compoſe an order diſtinct and ſeparate from the other orders of the ſtate. They did not form a body united by particular laws, under a chief whoſe authority extended to all his inferiors. The dignity of ſovereign pontiff was unknown at Athens; and each of the prieſts ſerved his particular temple, unconnected with his brethren. The temples, indeed, of the principal deities; thoſe of Minerva, for inſtance, of Neptune, of Ceres, and of Proſerpine, had many miniſters; and in each of them a chief preſided, who had the title of *High Prieſt*. The number of ſubaltern miniſters was in proportion to the rank of the deity; but the prieſts of one temple were altogether a ſeparate ſociety from thoſe of another. Thus at Athens there was a great number of high-prieſts, becauſe many deities were worſhipped there, whoſe ſervice required many miniſters. The power of each prieſt was confined to his temple; and there was no ſovereign pontiff, the miniſter general of the gods, and the preſident at all the feaſts.

It naturally follows from this account, that the miniſters of the gods at Athens were not judges in matters of religion. They were neither authorized to take cognizance of crimes committed againſt the deity, nor to puniſh them. Their function was to offer ſacrifices to the gods, and to entreat their acceptance of the adorations of the people. But the puniſhment of impiety, of ſacrilege, of the profanation of myſteries, and of other irreligious crimes, was not entruſted to their zeal.

The prieſts were not only incapable of avenging crimes againſt religion by a temporal proceſs; they even could not, without an expreſs order either from the ſenate or the people, exerciſe their right of devoting criminals to the infernal gods. It was in conſequence of a civil ſentence pronounced againſt Alcibiades, that the Eumolpidæ launched their anathema againſt him. It was in virtue of another decree that they revoked their imprecations, when his countrymen wanted his ſervice, and therefore reſtored him to their favour.

Religious cauſes, according to M. de Bougainville, fell under the juriſdiction of the Heliaſtæ.

The government, though often altered, continued pretty much on the plan eſtabliſhed by Solon.

The people of Athens were freemen, ſojourners, or 184
ſlaves. The citizens, called in Greek *Politai*, were very numerous; but what may ſeem ſtrange, were as many in the time of Cecrops as in the moſt flouriſhing ſtate of the commonwealth, hardly ever exceeding 20,000. It was Solon who decreed that none ſhould be accounted free but ſuch as were Athenians both by father and mother. After his time it fell into deſuetude, till revived by Pericles; and was again at his inſtance repealed. After the expulſion of the 30 tyrants, Solon's law was reſtored. A perſon born of a ſtranger was ſtyled *Nothos*, a baſtard; whereas the ſon of a free woman was called *Cneſios*, i. e. *legitimate*. There was in Cynoſarges a court of judicature, to which cauſes of illegitimacy properly belonged; and the utmoſt care was taken to prevent any from being enrolled Athenian citizens, who had not a clear title thereto. The citizens were divided by Cecrops into four tribes: the firſt called *Cecropes*, from Cecrops; the ſecond, *Antochthon*, from a king of that name; the third, *Actai*, from Acteus, another king of Athens, or rather from *Acte*, which ſignifies a *ſhore*; the fourth, *Puralia*: theſe names were altered by Cranaus, and again by Ericthonius. In the reign of Erictheus, they were again changed; the ſoldiers were called *Oblitai*, the craftſmen *Ergatai*, the farmers *Georgoi*, the graziers and ſhepherds *Aigicorai*: in this ſtate they were when Solon ſettled the commonwealth, and appointed the ſenate to be compoſed of 400, 100 out of each tribe. Clyſthenes increaſed the number of the tribes to ten; and made the ſenate conſiſt of 500, taking 50 out of each tribe. In ſucceeding times, two other tribes were added. Each tribe was ſubdivided into its *Demoi* or wards; and with reſpect to theſe it was that Solon inſtituted the public feaſts before-mentioned, at which ſometimes the whole tribe aſſembled, ſometimes ſeveral wards, and ſometimes only the inhabitants of one ward.

People divided into different tribes, &c.

The ſecond ſort of inhabitants we mentioned were called *Metoicoi*, i. e. *ſojourners*; theſe were perſons who lived always at Athens, yet were not admitted free denizens: as for ſuch as did not conſtantly reſide in Athens, they were ſtyled *Xenoi*; i. e. *ſtrangers*. The ſojourners were obliged to chooſe out of the citizens protectors, who were ſtyled *Patrons*; they paid ſervices to the ſtate, and beſides theſe an annual tribute of 12 drachms for every man, and ſix for every woman; but ſuch as had ſons, and paid for them, were exempted.

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exempted. If people fell to poverty, and were not able to pay the tribute, they were ſeized by the tax-maſters, and actually ſold for ſlaves; which, as Diogenes Laertius tells us, was the fate of Xenocrates the philoſopher. The ſojourners in Attica were under the ſame law as thoſe in Athens. As to ſervants, they were freemen, who through indigency were driven to receive wages, and while they were in this ſtate had no vote in the aſſembly. As to ſlaves, they were abſolutely the property of their maſters, and as ſuch were uſed as they thought fit: They were forbidden to wear clothes, or to cut their hair like their maſters; and, which is indeed amazing, Solon prohibited them to love boys, as if that had been honourable: They were likewiſe debarred from anointing or perfuming themſelves, and from worſhipping certain deities: They were not allowed to be called by honourable names; and in moſt other reſpects were uſed like dogs. They ſtigmatized them at their pleaſure, that is, branded them with letters in the forehead and elſewhere. However, Theſeus's temple was allowed them as a ſanctuary, whither, if they were exceedingly ill uſed, they might fly, and thereby oblige their owners to let them be transferred to another maſter. In this and many other reſpects the Athenian ſlaves were in a much better condition than thoſe throughout the reſt of Greece: they were permitted to get eſtates for themſelves, giving a ſmall premium to their maſters, who were obliged to make them free if they could pay their ranſom; they likewiſe obtained the ſame favour from the kindneſs of their maſters, or for having rendered military ſervices to the ſtates. When they were made free, they were obliged to chooſe patrons; and had likewiſe the privilege of chooſing a curator, who, in caſe their patrons injured them, was bound to defend them.

185 General aſſembly of the people.

The general aſſembly of the people, which Solon made the dernier reſort, was called the *Eccleſia*; and conſiſted of all the freemen of Athens, excepting ſuch as were *atimoi* or infamous. The meetings of theſe aſſemblies were either ordinary or extraordinary. The ordinary were ſuch as were appointed by law, the extraordinary ſuch as neceſſity required. Of the firſt there were four in 35 days. In the firſt aſſembly they approved or rejected magiſtrates, heard propoſals for the public good, and certain cauſes. In the ſecond they received petitions, and heard every man's judgement on the matters that were before them. In the third they gave audience to foreign ambaſſadors. The fourth was employed altogether in affairs relating to the gods and their worſhip. The extraordinary meetings were appointed by the magiſtrates when occaſion required, whereas to the ordinary aſſemblies the people came of their own accord. The firſt were held either in the market-place, in the Pnyx a place near the citadel, or in the theatre of Bacchus: as to the latter, the magiſtrates who appointed the extraordinary meeting appointed alſo the place where it ſhould be held. If any ſudden tempeſt roſe, or any earthquake happened, or any ſign notoriouſly inauſpicious appeared, the aſſembly was immediately adjourned, to prevent the people from apprehending unhappy conſequences from their deliberations. But if the weather was fair and ſerene, and nothing happened out of the ordinary courſe of things, they proceeded to purify the place where the aſſembly was held, which was done by ſprinkling it round with the blood of young pigs; then the crier made a ſolemn prayer for the proſperity of the republic, and that heaven would beſtow a happy iſſue on their counſels and undertakings: he then pronounced a bitter execration againſt any who ſhould in that aſſembly propound what might be diſadvantageous to the ſtate. Theſe ceremonies being over, they proceeded to buſineſs.

186 Method of giving their opinions.

There were ſeveral magiſtrates who had the overſeeing and regulating theſe aſſemblies. Theſe were firſt, the Epiſtate, or preſident of the aſſembly, who was choſen by lot out of the Proedri: his office was to give the ſignal for the people's voting. Next to him were the Prytanes, i. e. a committee of the ſenate, who of courſe were preſent on this occaſion: by their order a programma, or ſcheme of the buſineſs to be propoſed at the aſſembly, was previouſly ſet up in ſome public place, that every man might know what buſineſs to apply his thoughts to. The Proedri were nine in number, appointed by lots out of all the tribes to which the Prytanes did not belong: they had the right of propoſing to the people what they were to deliberate upon, and their office ended with the aſſembly; there ſat with them aſſeſſors, who were to take care that nothing they propoſed was detrimental to the commonwealth. The firſt ſtep to buſineſs was the crier's reading the decree of the ſenate whereon the aſſembly was to deliberate; when he had finiſhed this, he made proclamation in theſe words: *Who of the men above 50 will make an oration?* When the old men had done ſpeaking, the crier made proclamation again that any Athenian might then offer his ſentiments, whom the law allowed ſo to do; that is, all ſuch as were above 30 years old, and were not infamous. If ſuch a one roſe up to ſpeak, the Prytanes interpoſed, and bid him be ſilent; and if he did not obey them, the lictors pulled him down by force. When the debates were over, the preſident permitted the people to vote; which they did by caſting firſt beans, but in after times pebbles, into certain veſſels: theſe were counted, and then it was declared that the decree of the ſenate was either rejected or approved: after which, the Prytanes diſmiſſed the aſſembly.

187 The ſenate.

The ſenate was inſtituted by Solon to prevent the dangerous conſequences of leaving the ſupreme power in the people. At the time of his inſtitution, it was to conſiſt of 400, 100 out of each tribe; it was increaſed to 500, when the tribes were augmented to 10; and when they came to 12, it was alſo ſwelled to 600. They were elected by lots after this manner: At a day appointed, towards the cloſe of the year, the preſident of each tribe gave in a liſt of ſuch perſons belonging thereto, as were fit for and deſired to appear for this dignity: theſe names were engraven on tables of braſs, and a number of beans equal to the number of the amount of them, among which were 100 white ones, put into a veſſel; and then the names of the candidates and the beans were drawn one by one, and ſuch as were drawn by the white beans were received into the ſenate. After the ſenate was elected, they proceeded to appoint the officers who were to preſide in the ſenate: theſe were the Prytanes before-mentioned; and they were elected thus: The names of the ten tribes were thrown into one veſſel, and nine black beans and a white one into another veſſel. Then the names of the tribes

tribes were drawn with the beans. The tribe to which the white bean anſwered, preſided firſt; and the reſt
188 according to the order in which they were drawn.

Prytanes.

The Prytanes, while the ſenate conſiſted of 500, were 50 in number. For the farther avoiding of confuſion, therefore, 10 of theſe preſided a week, during which ſpace they were called *Proedri;* and out of theſe an Epiſtate or preſident was choſen, whoſe office laſted but one day, and by law no man could hold it more than once: the reaſon of this was, that he had in his cuſtody the public ſeal, the keys of the citadel, and the charge of the exchequer. The reader muſt diſtinguiſh between the Epiſtates and Proedri laſt mentioned, and thoſe ſpoken of in the former paragraph, becauſe, though their titles were the ſame, their offices were perfectly diſtinct. The ſenate aſſembled by direction of the Prytanes once every day, excepting feſtivals, and ſometimes oftener in the ſenate-houſe, which
189 was thence called *Prytaneum.*

Laws how eſtabliſhed, &c.

When a member of the ſenate made a motion for a new law, it was immediately engraven on tablets, that the members when they came next might be prepared to ſpeak to it. At the ſubſequent aſſembly the Epiſtates opened the matter; after which every ſenator that pleaſed delivered his ſentiments; then any of the Prytanes drew up the decree, and repeated it aloud: after which they proceeded to vote; and if there was a majority of white beans, then it became *pſephiſma*, and was afterwards propounded to the people: if they approved it, it became a law; otherwiſe it was of no force longer than the ſenate who decreed it ſubſiſted. The power of the ſenate was very great; for they took the account of magiſtrates at the expiration of their offices; they directed the proviſions made for poor citizens out of the public treaſure; they had the ſuperintendency of public priſons, and a power of puniſhing ſuch as committed acts morally evil, though not prohibited by any law; they had the care likewiſe of the fleet; and beſides all theſe they had many other branches of authority, which it is not neceſſary for us to mention. Before they took their ſeats, they were conſtrained to undergo a very ſtrict examination, wherein the whole courſe of their lives was inquired into; and if the leaſt ſlur on their reputation appeared, they were ſet aſide. When this examination was over, they took an oath, whereby they bound themſelves to promote in all their counſels the public good, to adviſe nothing contrary to the laws, and to execute their functions exactly. The higheſt fine the ſenate could impoſe was 500 drachms: if they thought the offender deſerved a heavier mulct, they then tranſmitted the cauſe to the Theſmothetæ, who puniſhed them as they thought fit. The ſenators, when their year was out, gave an account of their management to the people: but that they might have the leſs to do, they always puniſhed ſuch of their number as they found had offended by expulſion; and in this they were mighty exact. Yet an expelled ſenator was notwithſtanding eligible to any other office, the moſt trivial omiſſion being ſufficient to occaſion a diſmiſſion from the ſenatorial dignity; and therefore, when the tribes choſe their ſenators, they alſo choſe a certain number of ſubſidiaries, out of which, when a ſenator was expelled, another was ſubſtituted in his place. Each ſenator was allowed a drachm every day: for it was a conſtant rule with the Athenians, that the public ought to pay for every man's time; and therefore ſuch of the poor Athenians as thought fit to demand it, had three oboli for going to the aſſembly. If during their adminiſtration any ſhips of war were built, the ſenators had crowns decreed them; but if not, they were forbid to ſue for them.

Next to the ſenate was the court of AREOPAGUS; for a deſcription of which ſee that article. 190

Archons, Nomophylaces, &c.

The chief magiſtrates of Athens were Archons, and inferior to them there were many others; of whom it will be neceſſary to mention ſome. In the firſt place they had Nomophylaces, who were alſo ſtyled *the eleven*, becauſe they were ſo many in number, one choſen out of each tribe, and a clerk or ſecretary who made up the eleventh. Their duty it was to look to the execution of the laws: they had authority to ſeize robbers and other capital offenders; and if they confeſſed, to put them to death. Dr Potter thinks they reſembled our ſheriffs. The Phylarchi were the preſidents of the Athenian tribes; but in time this became a military title. The Philobaſileus was an officer in each tribe, who did the ſame things within his juriſdiction as the Baſileus did with reſpect to the ſtate. The Demarchi were the principal magiſtrates in wards. The Lexarchi were ſix in number, and were bound to take care that the people came duly to the aſſemblies; in their cuſtody was the public regiſter of the citizens names. They had under them Toxotæ, who were lictors or bailiffs; they were ſometimes 1000 in number: theſe men were neceſſary: but, like moſt of their ſort, were in a manner infamous, as may be gathered from the comedies of Ariſtophanes; they were generally Scythians, raw-boned, brawny fellows, ready to execute any thing they were commanded. The Nomothetæ were 1000 in number; their buſineſs was to watch over and inſpect into the laws. There were two ſorts of orators in the ſervice of the ſtate. Some were appointed to defend an old law, when a motion was made to repeal it; theſe had their fee from the ſtate, but the ſame man was incapable of being elected twice. Beſides theſe, there were 10 ſettled orators called *Rhetores*, elected by lot; their buſineſs was to plead public cauſes in the ſenate houſe. For this they had their ſtated fees; and with reſpect to their qualifications, the 191

Laws regarding orators.

law run thus: "Let no one be a public orator who hath ſtruck his parents, denied them maintenance, or ſhut them out of his doors; who hath refuſed to ſerve in the army; who hath thrown away his ſhield; who hath been addicted to lewd women, notoriouſly effeminate, or has run out his patrimony. If any man who has been guilty of theſe crimes dare to deliver an oration, let him be brought to trial upon the ſpot. Let an orator have children lawfully begotten, and an eſtate within Attica; if in his oration he talks impertinently, makes idle repetitions, affects an unbecoming raillery, digreſſes from the point in queſtion, or, after the aſſembly is over, abuſes the preſident, let the Proedri fine him 50 drachms; and if that is not thought enough, let him be brought before the next aſſembly and fined again." 192

Courts of juſtice.

We ſhall conclude this draught of the Athenian government with an account of their courts of juſtice, which, excluſive of the Areopagus, were 10 in number; four had cognizance of criminal, and ſix of civil cauſes. Theſe 10 courts were numbered with the 10 firſt

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first letters of the alphabet, and were thence styled, *Alpha, Beta, Gamma*, &c. When an Athenian was at leisure to hear causes, he wrote his own name, that of his father, and the ward to which he belonged, upon a tablet; this he presented to the Thesmothetæ, who returned it again to him with another tablet, with the letter which fell to his lot; then he went to the crier of the court, who presented him a sceptre, and gave him admission. When the causes were over, every judge went and delivered his sceptre to the Prytanes, and received a stated fee for every cause that was tried. But this was intended only to compensate their loss of time; so, that there might be no appearance of covetousness, a man was forbid to sit in two courts on the same day. The first criminal court after the Areopagus, was that of the *Ephetæ*. It consisted of 51 members, all upwards of 51 years old. Draco gave it a very extensive jurisdiction; but Solon took away from them the power of judging in any other causes than those of manslaughter, accidental killing, and lying in wait to destroy: the Basileus entered all causes in this court. The second criminal court was called *Delphinium*, because it was held in the temple of Apollo Delphinius; it had cognizance of such murders as were confessed by the criminal, but at the same time justified under some pretence or other. The *Prytaneum* was the third criminal court. It held plea of such cases where death ensued from inanimate things: causes were heard here with the same solemnity as in other courts; and on judgment given, the thing, whatever it was, that had occasioned the death of a man, was thrown out of the territory of Athens. The last criminal court was styled *Phreatum*. It sat in a place not far from the sea shore; and such persons were brought before this court as had committed murders in their own country and fled to Attica; the proceedings of this court were so severe, that they did not permit the criminal to come on shore, but obliged him to plead his cause in his vessel; and if he was found guilty, he was committed to the mercy of the winds and seas.

Of the judicatures for hearing civil causes, the first was the *Parabaston*, so called, as some think, because in it no matter could be heard if the cause of action was above one drachm. The *Cainon*, or new court, was the second tribunal. The third was styled the *court of Lycus*, because it assembled in a temple dedicated to that hero, whose statue, represented with the face of a wolf, was set up in all courts of justice. The *Trigonon* was so called, because it was triangular in its form. The court *Metidius* derived its appellation from the architect who built it. The sixth and last court was called *Heliæa;* it was by far the greatest, and is generally conceived to have derived its name from the judges sitting in the open air exposed to the sun. All the Athenians who were free citizens were allowed by law to sit in these courts as judges; but before they took their seats were sworn by Apollo Patrius, Ceres, and Jupiter the king, that they would decide all things righteously and according to law, where there was any law to guide them; and by the rules of natural equity, where there was none. The Helæastic court consisted at least of 50, but its usual number was 500, judges; when causes of very great consequence were to be tried, 1000 sat therein; and now and then the judges were increased to 1500, and even to 2000. There were many inferior courts in Athens for the decision of trivial causes; but of these there is no necessity of speaking, since we design no more than a succinct view of the Athenian republic, as it was settled by and in consequence of Solon's laws.

Atticus, Attila.

ATTICUS, Titus Pomponius, one of the most honourable men of ancient Rome. He understood the art of managing himself with such address, that without leaving his state of neutrality, he preserved the esteem and affection of all parties. His strict friendship with Cicero did not hinder him from having great intimacy with Hortensius. The contests at Rome between Cinna's party and that of Marius induced him to go to Athens, where he continued for a long time. He was very fond of polite learning, and kept at his house several librarians and readers. He might have obtained the most considerable posts in the government; but chose rather not to meddle, because in the corruption and faction which then prevailed he could not discharge them according to the laws. He wrote Annals. He married his daughter to Agrippa; and attained to the age of 77.

ATTILA, king of the Huns, surnamed *the scourge of God*, lived in the 5th century. He may be ranked amongst the greatest conquerors, since there was scarcely any province in Europe which did not feel the weight of his victorious arms.

Attila deduced his noble, perhaps his regal, descent from the ancient Huns, who had formerly contended with the monarchs of China. His features, according to the observation of a Gothic historian, bore the stamp of his national origin: and the portrait of Attila exhibits the genuine deformity of a modern Calmuck; a large head, a swarthy complexion, small deep-seated eyes, a flat nose, a few hairs in the place of a beard, broad shoulders, and a short square body, of nervous strength, though of a disproportioned form. The haughty step and demeanour of the king of the Huns expressed the consciousness of his superiority above the rest of mankind; and he had a custom of fiercely rolling his eyes, as if he wished to enjoy the terror which he inspired. Yet this savage hero was not inaccessible to pity; his suppliant enemies might confide in the assurance of peace or pardon; and Attila was considered by his subjects as a just and indulgent master. He delighted in war: but, after he had ascended the throne in a mature age, his head, rather than his hand, achieved the conquest of the north; and the fame of an adventurous soldier was usefully exchanged for that of a prudent and successful general. The effects of personal valour are so inconsiderable, except in poetry or romance, that victory, even among barbarians, must depend on the degree of skill, with which the passions of the multitude are combined and guided for the service of a single man. The arts of Attila were skilfully adapted to the character of his age and country. It was natural enough, that the Scythians should adore, with peculiar devotion, the god of war; but as they were incapable of forming either an abstract idea, or a corporeal representation, they worshipped their tutelar deity under the symbol of an iron scimitar. One of the shepherds of the Huns perceived, that a heifer, who was grazing, had wounded herself in the foot; and curiously followed the track of the blood, till he discovered, among the long grass, the

Gibbon's Rome, vol. iii. p. 357.

Attila.

the point of an ancient ſword; which he dug out of the ground, and preſented to Attila. That magnanimous, or rather that artful, prince, accepted with pious gratitude this celeſtial favour; and, as the rightful poſſeſſor of the *ſword of Mars*, aſſerted his divine and indefeaſible claim to the dominion of the earth. If the rites of Scythia were practiſed on this ſolemn occaſion, a lofty altar, or rather pile of faggots, 300 yards in length and in breadth, was raiſed in a ſpacious plain; and the ſword of Mars was placed erect on the ſummit of this ruſtic altar, which was annually conſecrated by the blood of ſheep, horſes, and of the hundredth captive. Whether human ſacrifices formed any part of the worſhip of Attila, or whether he propitiated the god of war with the victims which he continually offered in the field of battle, the favourite of Mars ſoon acquired a ſacred character, which rendered his conqueſts more eaſy and more permanent; and the barbarian princes confeſſed, in the language of devotion or flattery, that they could not preſume to gaze with a ſteady eye on the divine majeſty of the king of the Huns. His brother Bleda, who reigned over a conſiderable part of the nation, was compelled to reſign his ſceptre and his life. Yet even this cruel act was attributed to a ſupernatural impulſe; and the vigour with which Attila wielded the ſword of Mars, convinced the world that it had been reſerved alone for his invincible arm. But the extent of his empire affords the only remaining evidence of the number and importance of his victories; and the Scythian monarch, however ignorant of the value of ſcience and philoſophy, might perhaps lament that his illiterate ſubjects were deſtitute of the art which could perpetuate the memory of his exploits.

If a line of ſeparation were drawn between the civilized and the ſavage climates of the globe; between the inhabitants of cities who cultivated the earth and the hunters and ſhepherds who dwelt in tents; Attila might aſpire to the title of ſupreme and ſole monarch of the Barbarians. He alone, among the conquerors of ancient and modern times, united the two mighty kingdoms of Germany and Scythia; and thoſe vague appellations, when they are applied to his reign, may be underſtood with an extenſive latitude. Thuringia, which ſtretched beyond its actual limits as far as the Danube, was in the number of his provinces: he interpoſed, with the weight of a powerful neighbour, in the domeſtic affairs of the Franks; and one of his lieutenants chaſtiſed, and almoſt exterminated, the Burgundians of the Rhine. He ſubdued the iſlands of the ocean, the kingdoms of Scandinavia, encompaſſed and divided by the waters of the Baltic; and the Huns might derive a tribute of furs from that northern region, which has been protected from all other conquerors by the ſeverity of the climate, and the courage of the natives. Towards the eaſt, it is difficult to circumſcribe the dominion of Attila over the Scythian deſerts: yet we may be aſſured, that he reigned on the banks of the Volga; that the king of the Huns was dreaded, not only as a warrior, but as a magician; that he inſulted and vanquiſhed the khan of the formidable Geougen; and that he ſent ambaſſadors to negociate an equal alliance with the empire of China. In the proud review of the nations who acknowledged the ſovereignty of Attila, and who never entertained during his lifetime the thought of a revolt, the Gepidæ and the Oſtrogoths were diſtinguiſhed by their numbers, their bravery, and the perſonal merit of their chiefs. The renowned Ardaric king of the Gepidæ, was the faithful and ſagacious counſellor of the monarch; who eſteemed his intrepid genius, whilſt he loved the mild and diſcreet virtues of the noble Walamir king of the Oſtrogoths. The crowd of the vulgar kings, the leaders of ſo many martial tribes, who ſerved under the ſtandard of Attila, were ranged in the ſubmiſſive order of guards and domeſtics round the perſon of their maſter. They watched his nod; they trembled at his frown; and at the firſt ſignal of his will, they executed without murmur or heſitation his ſtern and abſolute commands. In time of peace, the dependent princes, with their national troops, attended the royal camp in regular ſucceſſion; but when Attila collected his military force, he was able to bring into the field an army of five, or, according to another account, of ſeven hundred thouſand Barbarians.

Attire || Attorney.

The death of Attila was attended with ſingular circumſtances. He had married a new wife, a beautiful virgin named *Ildico*. His nuptials were celebrated with great feſtivity, at his palace beyond the Danube, and he retired late to bed oppreſſed with wine. In the night, a blood-veſſel burſt in his lungs, which ſuffocated him. The bride was found in the morning ſitting by the bedſide, lamenting his death and her own danger. The body of Attila was expoſed in the plain, while the Huns, ſinging funeral ſongs to his praiſe, marched round it in martial order. The body, encloſed in three coffins, of gold, ſilver, and iron, was privately interred during the night; and to prevent the violation of his remains by the diſcovery of the place where he was buried, all the captive ſlaves who were employed in the ſolemnity were barbarouſly maſſacred. This happened about the year 453. With Attila ended the empire of the Huns. His ſons, by diſſenſion and civil war, mutually deſtroyed each other, or were diſpoſſeſſed by more powerful and independent chieftains.

For a farther account of his exploits, ſee the article Huns.

ATTIRE, in *Hunting*, ſignifies the head or horns of a deer. The attire of a ſtag, if perfect, conſiſts of bur, pearls, beam, gutters, antler, ſur-antler, royal, ſur-royal, and crotches; of a buck, of the bur, beam, brow-antler, advancer, palm, and ſpellers.

ATTITUDE, in *Painting* and *Sculpture*, the geſture of a figure or ſtatue; or it is ſuch a diſpoſition of their parts as ſerves to expreſs the action and ſentiments of the perſon repreſented.

ATTIUM, in *Ancient Geography*, a promontory on the north-weſt of Corſica, (Ptolemy). It ſtill retains ſome traces of its ancient name, being now called *Punta di Acciuolo* (Cluverius).

ATTLEBURY, a town in the county of Norfolk in England. E. Long. 0. 40. N. Lat. 52. 23.

ATTOLLENS, in *Anatomy*, an appellation given to ſeveral muſcles, otherwiſe called *levatores* and *elevatores*. See Anatomy, *Table of the Muſcles*.

ATTORNEY at law, anſwers to the Procurator or Proctor of the civilians and canoniſts: And he is one who is put in the place, ſtead, or turn, of another, to manage his matters of law. Formerly every

ſuitor

Attorney. suitor was obliged to appear in person, to prosecute or defend his suit (according to the old Gothic constitution), unless by special license under the king's letters patent. This is still the law in criminal cases. And an idiot cannot to this day appear by attorney, but in person; for he hath not discretion to enable him to appoint a proper substitute: and upon his being brought before the court in so defenceless a condition, the judges are bound to take care of his interests, and they shall admit the best plea in his behalf that any one present can suggest. But, as in the Roman law, *cum olim in usu fuisset, alterius nomine agi non posse, sed quia hoc non minimam incommoditatem habebat, cœperunt homines per procuratores litigare*; so, with us, on the same principle of convenience, it is now permitted in general, by divers ancient statutes, whereof the first is statute West. 2. c. 10. that attorneys may be made to prosecute or defend any action in the absence of the parties to the suit. These attorneys are now formed into a regular corps; they are admitted to the execution of their office by the superior courts of Westminster hall; and are in all points officers of the respective courts in which they are admitted; and as they have many privileges on account of their attendance there, so they are peculiarly subject to the censure and animadversion of the judges. No man can practise as an attorney in any of those courts, but such as is admitted and sworn an attorney of that particular court: an attorney of the court of king's bench cannot practise in the court of common pleas; nor *vice versa.* To practise in the court of chancery, it is also necessary to be admitted a solicitor therein: and by the statute 22 Geo. II. c. 46. no person shall act as an attorney at the court of quarter-sessions, but such as has been regularly admitted in some superior court of record. So early as the statute 4 Hen. IV. c. 18. it was enacted, that attorneys should be examined by the judges, and none admitted but such as were virtuous, learned, and sworn to do their duty. And many subsequent statutes have laid them under farther regulations.

Letter of attorney pays by different acts, 6s. By 25 Geo. III. c. 80. the following duties are to be paid by every solicitor, attorney, notary, proctor, agent, or procurator, viz. for every warrant to prosecute for a debt of 40s. or to defend, a stamp duty of 2s. 6d. And they are to take out certificates annually; and if resident in London, Westminster, the bills of mortality, or Edinburgh, they are now obliged to pay 5l. for the same; and in every other part of Great Britain, 3l. The duties are under the management of the commissioners of stamps: and every acting solicitor, and other persons as above, shall annually deliver in a note of his name and residence, to the proper officer of the court in which he practises; the entering officers are to certify notes delivered, and issue annual certificates, stamped as above, which must be renewed ten days before the expiration. Refusing to issue, or improperly issuing certificates, is a penalty of 50l. and damages to the party aggrieved. Acting without a certificate, or giving in a false place of residence, is a penalty of 50l. and incapacity to sue for fees due. A stamped memorandum shall be given to the proper officer, of the names of the parties in every action; and in such cases as used to require precipes. Officers who receive stamped memorandums, are to file the same, on penalty of 50l. and persons not acting conformable to this act forfeit 5l.

Attourn-ment, Attraction.

Attorney General, is a great officer under the king, made by letters patent. It is his place to exhibit informations, and prosecute for the crown, in matters criminal; and to file bills in the exchequer, for any thing concerning the king in inheritance or profits; and others may bring bills against the king's attorney. His proper place in court, upon any special matters of a criminal nature, wherein his attendance is required, is under the judges on the left hand of the clerk of the crown: but this is only upon solemn and extraordinary occasions; for usually he does not sit here, but within the bar in the face of the court.

ATTOURNMENT, or ATTORNMENT, in *Law*, a transfer from one lord to another of the homage and service a tenant makes; or that acknowledgment of duty to a new lord.

ATTRACTION, in *Natural Philosophy*, a general term used to denote the cause by which bodies tend towards each other, and cohere till separated by some other power.

The principle of attraction, in the Newtonian sense of it, seems to have been first surmised by Copernicus. "As for gravity," says Copernicus, "I consider it as nothing more than a certain natural appetence (*appetentia*) that the Creator has impressed upon all the parts of matter, in order to their uniting or coalescing into a globular form, for their better preservation; and it is credible that the same power is also inherent in the sun and moon, and planets, that those bodies may constantly retain that round figure in which we behold them." *De Rev. Orb. Cœlest.* lib. i. cap. 9. And Kepler calls gravity a corporeal and mutual affection between similar bodies, in order to their union. *Ast. Nov. in Introd.* And he pronounces more positively, that no bodies whatsoever were absolutely light, but only relatively so; and consequently, that all matter was subjected to the law of gravitation. *Ibid.*

The first in this country who adopted the notion of attraction was Dr Gilbert, in his book *De Magnete*; and the next was the celebrated Lord Bacon, *Nov. Organ.* lib. ii. aphor. 36. 45. 48. *Sylv.* cent. i. exp. 33. In France it was received by Fermat and Roberval; and in Italy by Galileo and Borelli. But till Sir Isaac Newton appeared, this principle was very imperfectly defined and applied.

It must be observed, that though this great author makes use of the word attraction, in common with the school philosophers; yet he very studiously distinguishes between the ideas. The ancient attraction was supposed a kind of quality, inherent in certain bodies themselves, and arising from their particular or specific forms. The Newtonian attraction is a more indefinite principle; denoting not any particular kind or manner of action, nor the physical cause of such action; but only a tendency in the general, a *conatus accedendi*, to whatever cause, physical or metaphysical, such effect be owing; whether to a power inherent in the bodies themselves, or to the impulse of an external agent. Accordingly, that author, in his *Philosoph. Nat. Prin. Math.* notes, "that he uses the words *attraction, impulse*, and *propension* to the centre, indifferently; and cautions the reader not to imagine that by

Attraction. by attraction he expresses the modus of the action, or the efficient cause thereof, as if there were any proper powers in the centres, which in reality are only mathematical points; or as if centres could attract." lib. i. p. 5. So he "considers centripetal powers as attractions, though, physically speaking, it were perhaps more just to call them impulses." *Ib.* p. 147. He adds, "that what he calls attraction may possibly be effected by impulse, though not a common or corporeal impulse, or after some other manner unknown to us." *Optic.* p. 322.

Attraction, if considered as a quality arising from the specific forms of bodies, ought, together with sympathy, antipathy, and the whole tribe of occult qualities, to be exploded. But when we have set these aside, there will remain innumerable phenomena of nature, and particularly the gravity or weight of bodies, or their tendency to a centre, which argue a principle of action seemingly distinct from impulse, where at least there is no sensible impulsion concerned. Nay, what is more, this action in some respects differs from all impulsion we know of; impulse being always found to act in proportion to the surfaces of bodies, whereas gravity acts according to their solid content, and consequently must arise from some cause that penetrates or pervades the whole substance thereof. This unknown principle, unknown we mean in respect of its cause, for its phenomena and effects are most obvious, with all the species and modifications thereof, we call *attraction;* which is a general name, under which all mutual tendencies, where no physical impulse appears, and which cannot therefore be accounted for from any known laws of nature, may be ranged.

And hence arise divers particular kinds of attraction; as, *Gravity*, *Magnetism*, *Electricity*, &c. which are so many different principles acting by different laws, and only agreeing in this, that we do not see any physical causes thereof; but that, as to our senses, they may really arise from some power or efficacy in such bodies, whereby they are enabled to act even upon distant bodies, though our reason absolutely disallows of any such action.

Attraction may be divided, with respect to the law it observes, into two kinds.

1. That which extends to a sensible distance. Such are the attraction of gravity, found in all bodies; and the attraction of magnetism and electricity, found in particular bodies. The several laws and phenomena of each, see under their respective articles.

The attraction of gravity, called also among mathematicians the *centripetal force*, is one of the greatest and most universal principles in all nature. We see and feel it operate on bodies near the earth, and find by observation that the same power (i. e. a power which acts in the same manner, and by the same rules, viz. always proportionably to the quantities of matter, and as the squares of the distances reciprocally) does also obtain in the moon, and the other planets primary and secondary, as well as in the comets; and even that this is the very power whereby they are all retained in their orbits, &c. And hence, as gravity is found in all the bodies which come under our observation, it is easily inferred, by one of the settled rules of philosophizing, that it obtains in all others: and as it is found to be as the quantity of matter in each body, it must be in every particle thereof; and hence every particle in nature is proved to attract every other particle, &c. See Attraction, Astronomy *Index*.

From this attraction arises all the motion, and consequently all the mutation, in the material world. By this heavy bodies descend, and light ones ascend; by this projectiles are directed, vapours and exhalations rise, and rains, &c. fall. By this rivers glide, the air presses, the ocean swells, &c. In effect, the motions arising from this principle make the subject of that extensive branch of mathematics, called *mechanics* or *statics*, with the parts or appendages thereof, hydrostatics, pneumatics, &c.

2. That which does not extend to sensible distances. Such is found to obtain in the minute particles whereof bodies are composed, which attract each other at or extremely near the point of contact, with a force much superior to that of gravity, but which at any distance from it decreases much faster than the power of gravity. This power a late ingenious author chooses to call the *attraction of cohesion*, as being that whereby the atoms or insensible particles of bodies are united into sensible masses.

This latter kind of attraction owns Sir Isaac Newton for its discoverer; as the former does for its improver. The laws of motion, percussion, &c. in sensible bodies under various circumstances, as falling, projected, &c. ascertained by the later philosophers, do not reach to those more remote intestine motions of the component particles of the same bodies, whereon the changes of the texture, colour, properties, &c. of bodies depend: so that our philosophy, if it were only founded on the principle of gravitation, and carried so far as that would lead us, would necessarily be very deficient.

But beside the common laws of sensible masses, the minute parts they are composed of are found subject to some others, which have been but lately taken notice of, and are even yet imperfectly known. Sir Isaac Newton, to whose happy penetration we owe the hint, contents himself to establish that there are such motions in the *minima naturæ*, and that they flow from certain powers or forces, not reducible to any of those in the great world. In virtue of these powers, he shows, "That the small particles act on one another even at a distance; and that many of the phenomena of nature are the result thereof. Sensible bodies, we have already observed, act on one another divers ways: and as we thus perceive the tenor and course of nature, it appears highly probable that there may be other powers of the like kind; nature being very uniform and consistent with herself. Those just mentioned reach to sensible distances, and so have been observed by vulgar eyes; but there may be others which reach to such small distances as have hitherto escaped observation; and it is probable electricity may reach to such distances, even without being excited by friction.

The great author just mentioned proceeds to confirm the reality of these suspicions from a great number of phenomena and experiments, which plainly argue such powers and actions between the particles, e. g. of salts and water, sulphuric acid and water, nitre acid and iron, sulphuric acid and nitre. He also shows, that these powers, &c. are unequally strong between different bodies; stronger, e. g. between the particles of potash and those of nitric acid than those of silver, between nitric acid and zinc than iron, between iron and copper than silver or mercury. So sulphuric acid acts on water, but more on iron or copper, &c.

The other experiments which countenance the existence of such principle of attraction in the particles of matter are innumerable.

These actions, in virtue whereof the particles of the bodies above mentioned tend towards each other, the author calls by a general indefinite name *attraction*; which is equally applicable to all actions whereby distant bodies tend towards one another, whether by impulse or by any other more latent power: and from hence he accounts for an infinity of phenomena, otherwise inexplicable, to which the principle of gravity is inadequate.

"Thus (adds our author) will nature be found very conformable to herself and very simple; performing all the great motions of the heavenly bodies by the attraction of gravity, which intercides those bodies, and almost all the small ones of their parts, by some other attractive power diffused through the particles thereof. Without such principles, there never would have been any motion in the world; and without the continuance thereof, motion would soon perish, there being otherwise a great decrease or diminution thereof, which is only supplied by these active principles.

We need not say how unjust it is in the generality of foreign philosophers to declare against a principle which furnishes so beautiful a view, for no other reason but because they cannot conceive how one body should act on another at a distance. It is certain, philosophy allows of no action but what is by immediate contact and impulsion (for how can a body exert any active power there where it does not exist? to suppose this of any thing, even the Supreme Being himself, would perhaps imply a contradiction): yet we see effects without seeing any such impulse; and where there are effects, we can easily infer there are causes whether we see them or not. But a man may consider such effects without entering into the consideration of the causes, as indeed it seems the business of a philosopher to do: for to exclude a number of phenomena which we do see, will be to leave a great chasm in the history of nature; and to argue about actions which we do not see, will be to build castles in the air.—It follows, therefore, that the phenomena of attraction are matter of physical consideration, and as such entitled to a share in the system of physics; but that the causes thereof will only become so when they become sensible, *i. e.* when they appear to be the effect of some other higher causes (for a cause is no otherwise seen than as itself is an effect, so that the first cause must from the nature of things be invisible): we are therefore at liberty to suppose the causes of attractions what we please, without any injury to the effects.—The illustrious author himself seems a little irresolute as to the causes; inclining sometimes to attribute gravity to the action of an immaterial cause (*Optics*, p. 343, &c.) and sometimes to that of a material one (Ib. p. 325.)

In his philosophy, the research into causes is the last thing, and never comes under consideration till the laws and phenomena of the effect be settled; it being to these phenomena that the cause is to be accommodated. The cause even of any, the grossest and most sensible action, is not adequately known. How impulse or percussion itself produces its effects, i. e. how motion is communicated by body to body, confounds the deepest philosophers; yet is impulse received not only into philosophy, but into mathematics: and accordingly the laws and phenomena of its effects make the greatest part of common mechanics.

The other species of attraction, therefore, in which no impulse is remarkable, when their phenomena are sufficiently ascertained, have the same title to be promoted from physical to mathematical consideration; and this without any previous inquiry into their causes, which our conceptions may not be proportionate to: let their causes be occult, as all causes strictly speaking are, so that their effects, which alone immediately concern us, be but apparent.

Our great philosopher, then, far from adulterating science with any thing foreign or metaphysical, as many have reproached him with doing, has the glory of having thrown every thing of this kind out of his system, and of having opened a new source of sublimer mechanics, which duly cultivated might be of infinitely greater extent than all the mechanics yet known. It is hence alone we must expect to learn the manner of the changes, productions, generations, corruptions, &c. of natural things; with all that scene of wonders opened to us by the operations of chemistry.

Some of our own countrymen have prosecuted the discovery with laudable zeal: Dr Keill particularly has endeavoured to deduce some of the laws of this new action, and applied them to solve divers of the more general phenomena of bodies, as cohesion, fluidity, elasticity, softness, fermentation, coagulation, &c.; and Dr Freind, seconding him, has made a further application of the same principles, to account at once for almost all the phenomena that chemistry presents: so that some philosophers are inclined to think that the new mechanics should seem already raised to a complete science, and that nothing now can occur but what we have an immediate solution of from the attractive force.

But this seems a little too precipitate: A principle so fertile should have been further explored; its particular laws, limits, &c. more industriously detected and laid down, before we had proceeded to the application. Attraction in the gross is so complex a thing, that it may solve a thousand different phenomena alike. The notion is but one degree more simple and precise than action itself; and, till more of its properties are ascertained, it were better to apply it less and study it more. It may be added, that some of Sir Isaac Newton's followers have been charged with falling into that error which he industriously avoided, viz. of considering attraction as a cause or active property in bodies, not merely as a phenomenon or effect.

Attraction of Mountains. See Mountains.

Elective Attraction. See Chemistry *Index.*

ATTREBATII. See Atrebatii.

ATTRIBUTE, in a general sense, that which agrees with some person or thing; or a quality determining something to be after a certain manner. Thus understanding is an attribute of mind, and extension an attribute of body. That attribute which the mind conceives

conceives as the foundation of all the rest, is called its *essential attribute*; thus extension is by some, and solidity by others, esteemed the essential attribute of body or matter.

ATTRIBUTES, in *Theology*, the several qualities or perfections of the Divine nature.

ATTRIBUTES, in *Logic*, are the predicates of any subject, or what may be affirmed or denied of any thing.

ATTRIBUTES, in *Painting* and *Sculpture*, are symbols added to several figures, to intimate their particular office and character. Thus the eagle is an attribute of Jupiter; a peacock, of Juno; a caduce, of Mercury; a club, of Hercules; and a palm, of Victory.

ATTRIBUTIVES, in *Grammar*, are words which are significant of attributes; and thus include adjectives; verbs, and particles, which are attributes of substances; and adverbs, which denote the attributes only of attributes. Mr Harris, who has introduced this distribution of words, denominates the former *attributives of the first order*, and the latter *attributives of the second order*.

ATTRITION, the rubbing or striking of bodies one against another, so as to throw off some of their superficial particles.

ATURÆ, an ancient town in the district of Novempopulana in Aquitania, on the river Aturus; now Aire in Gascony, on the Adour. E. Long. 0. 3. N. Lat. 43. 40.

AVA, a kingdom of Asia, in the peninsula beyond the Ganges. The king is very powerful, his dominions being bounded by Mogulstan on the west, Siam, on the south, Tonquin and Cochin China on the east, and by Tibet and China on the north. Several large rivers run through this country, which annually overflow their banks like the Nile, and thus render it extremely fertile. Here are mines of lead and copper, together with some of gold and silver, besides large quantities of the finest oriental rubies, sapphires, emeralds, &c. See ASIA, N° 81. &c.

AVA, formerly the metropolis of the kingdom of the same name, is situated in E. Long. 96. 30. N. Lat. 21. 0. It is pretty large; the houses built with timber or bamboo canes, with thatched roofs, and floors made of teak plank or split bamboo. The streets are very straight, with rows of trees planted on each side. The king's palace is an exact quadrangle, each side of which is 800 paces, and is surrounded with a brick wall; but the palace itself is of stone. It has four gates: the golden gate, through which all ambassadors enter; the gate of justice, through which the people bring petitions, accusations, or complaints; the gate of grace, through which those pass who have received any favours, or have been acquitted of crimes laid to their charge; and the gate of state, through which his majesty himself passes when he shows himself to the people.

AVA AVA, a plant so called by the inhabitants of Otaheite, in the South-Sea, from the leaves of which they express an intoxicating juice. It is drunk very freely by the chiefs and other considerable persons, who vie with each other in drinking the greatest number of draughts, each draught being about a pint; but it is carefully kept from their women.

AVADOUTAS, a sect of Indian Bramins, who in austerity surpass all the rest. The other sects retain earthen vessels for holding their provisions, and a stick to lean on: but none of these are used by the Avadoutas; they only cover their nakedness with a piece of cloth; and some of them lay even that aside, and go stark naked, besmearing their bodies with cow-dung. When hungry, some go into houses, and, without speaking, hold out their hand; eating on the spot whatever is given them. Others retire to the sides of holy rivers, and there expect the peasants to bring them provisions, which they generally do very liberally.

AVAIL OF MARRIAGE, in *Scots Law*, that casualty in wardholding, by which the superior was entitled to a certain sum from his vassal, upon his attaining the age of puberty, as the value or avail of his tocher.

AVALANCHES, a name given to prodigious snow-balls that frequently roll down the mountains in Savoy, particularly Mount Blanc, to the extreme danger of such adventurous travellers as attempt to ascend those stupendous heights. Some of the avalanches are about 200 feet diameter; being fragments of the ice-rocks which break by their own weight from the tops of the precipices. See *Mount BLANC*.

AVALON, a small but ancient city of Burgundy in France, about 500 paces long and 300 broad. E. Long. 3. 5. N. Lat. 47. 38.

AVANIA, in the Turkish legislature, a fine for crimes and on deaths, paid to the governor of the place. In the places wherein several nations live together under a Turkish governor, he takes this profitable method of punishing all crimes among the Christians or Jews, unless it be the murder of a Turk.

AVARICUM, an ancient town of the Bituriges in Gallia Celtica, situated on the rivulet Avara, in a very fertile soil (Cæsar). Now *Bourges*, in Berry. E. Long. 2. 30. N. Lat. 47. 10.

AVAST, in the sea language, a term requiring to stop or to stay.

AVAUNCHERS, among hunters, the second branches of a deer's horns.

AUBAGNE, a town of Provence in France, situated on the river Veaune, on the road from Marseilles to Toulon. The states formerly held their sessions at this place. E. Long. 5. 52. N. Lat. 43. 17.

AUBAINE, in the old customs of France, a right vested in the king of being heir to a foreigner that dies within his dominions.

By this right the French king claimed the inheritance of all foreigners that died within his dominions, notwithstanding of any testament the deceased could make. An ambassador was not subject to the right of aubaine; and the Swiss, Savoyards, Scots, and Portuguese were also exempted, being deemed natives and regnicoles.

AUBENAS, a town of France, in the department of Ardeche, situated on the river Ardeche, at the foot of the mountains called the *Cevennes*. E. Long. 4. 32. N. Lat. 44. 40.

AUBENTON, a town of France, in the department of Aisne, situated on the river Aube. E. Long. 4. 25. N. Lat. 49. 51.

AUBETERRE, a town of France in the Angumois, on the river Dronne. E. Long. 0. 10. N. Lat. 45. 15.

AUBIGNE, a town of France, in the department of of Cher, situated on the river Verre, in a flat and agreeable country. It is surrounded with high strong walls, wide ditches, and high counterscarps. The castle is within the town, and is very handsome. E. Long. 2. 20. N. Lat. 47. 29.

AUBIGNEY, a dukedom in France belonging to the dukes of Richmond in England; confirmed to the present duke, and registered in the parliament of Paris 1777.

AUBIN DU COMIER, a town of France, in the department of Isle and Vilaine. W. Long. 1. 15. N. Lat. 48. 15.

AUBIN, in *Horsemanship*, a broken kind of gait, between an amble and a gallop, accounted a defect.

AUBONNE, a town of Switzerland, in the canton of Bern. E. Long. 5. 54. N. Lat. 48. 30. It is situated near a river of the same name, seven miles north of the lake of Geneva, upon an eminence which has a gentle declivity, at the foot of which runs the river with an impetuous torrent. The town is built in the form of an amphitheatre; on the upper part of which stands a very handsome castle with a fine court, and a portico supported by pillars of a single stone each; above there is a covered gallery that runs round the court; and as the castle stands high, there is a most delightful prospect, not only of the town and neighbouring fields, but of the whole lake of Geneva and the land that surrounds it. At Thonen, in Savoy, on the other side of the lake, is a town covered with tin, which makes a glittering appearance when the sun is in a certain position; and the castle of Aubonne has likewise a tower of the same kind, which at certain hours makes a similar appearance to the Savoyards. The bailiage of Aubonne contains several villages which are mostly at the foot of the mountain Jura. In one part of this mountain there is a very deep cave, wherein those that go down find a natural and perpetual icehouse. At the bottom is heard a great noise like that of a subterraneous river, which is supposed to be that of the river Aubonne, because it first appears, with several sources, about 100 paces from the foot of that mountain.

AUBREY, JOHN, a famous English antiquary, descended from an ancient family in Wiltshire, was born in 1626. He made the history and antiquities of England his peculiar study and delight; and contributed considerable assistance to the famous *Monasticon Anglicanum*. He succeeded to several good estates; but law-suits and other misfortunes consumed them all, so that he was reduced to absolute want. In this extremity he found a valuable benefactress in the Lady Long of Draycot in Wilts, who gave him an apartment in her house, and supported him to his death, which happened about the year 1700. He was a man of considerable ability, learning, and application, a good Latin poet, an excellent naturalist, but somewhat credulous, and tinctured with superstition. He left many works behind him. He wrote, 1. Miscellanies. 2. A Perambulation of the county of Surry, in five volumes, octavo. 3. The Life of Mr Hobbes of Malmsbury, 4. *Monumenta Britannica*, or a discourse concerning Stonehenge, and Roll-Rich stones in Oxfordshire. 5. *Architectonica Sacra*; and several other works still in manuscript.

AUBURN, a market-town in Wiltshire, in England. W. Long. 1. 20. N. Lat. 53. 20.

AUBUSSON, a small town of France, in the province of La Marche, and the government of the Lyonnois, now the department of Creuse. Its situation is very irregular, on the river Creuse, in a bottom surrounded with rocks and mountains. A manufacture of tapestry is carried on here, by which the town is rendered very populous. E. Long. 2. 15. N. Lat. 45. 58.

AUCAUGREL, the capital of the kingdom of Adel in Africa, seated on a mountain. E. Long. 44. 25. N. Lat. 9. 10.

AUCH, a city of France, the capital of the county of Armagnac, now the department of Gers, and the metropolis of all Gascony. The archbishop formerly assumed the title of primate of Aquitain. It lies on the summit and declivity of a very steep hill, which is surrounded by other hills that rise at a small distance; and through the vale below runs a rivulet, called the *Gers*. The inhabitants are about 6000; the buildings are modern and elegant; the streets, though in general narrow, yet are clean and well paved. In the centre of the city stands the cathedral, which is one of the most magnificent in France, both as to its construction and the internal decorations. The painted windows are only inferior to those of Gouda in Holland. The chapels are of equal beauty, and ornamented at a prodigious expence. The revenues of the see of Auch amount annually to three hundred thousand livres. The palace is a very handsome building; and its apartments are furnished with a voluptuous splendor, rather becoming a temporal than a spiritual prince. E. Long. 0. 40. N. Lat. 43. 40.

AUCTION, a kind of public sale, very much in use for houshold goods, books, plate, &c. By this method of sale the highest bidder is always the buyer. This was originally a kind of sale among the ancient Romans, performed by the public crier *sub hasta*, i. e. under a spear stuck up on that occasion, and by some magistrate, who made good the sale by delivery of the goods.

AUDEANISM, the same with anthropomorphism. See ANTHROPOMORPHITES.

AUDEUS, the chief of the Audeans, obtained the name of a heretic, and the punishment of banishment, for celebrating Easter in the manner of the Jews, and attributing a human form to the Deity. He died in the country of the Goths, about the year 370.

AUDIENCE given to ambassadors, a ceremony observed in courts at the admission of ambassadors or public ministers to a hearing.

In England, audience is given to ambassadors in the presence chamber; to envoys and residents, in a gallery, closet, or in any place where the king happens to be. Upon being admitted, as is the custom of all courts, they make three bows; after which they cover and sit down; but not before the king is covered and sat down, and has given them the sign to put on their hats. When the king does not care to have them covered, and sit, he himself stands uncovered; which is taken as a slight. At Constantinople, ministers usually have audience of the prime vizier.

Audience || Auditores.

Audience is alſo the name of a court of juſtice eſtabliſhed in the Weſt-Indies by the Spaniards, anſwering in effect to the parliament in France. Theſe courts take in ſeveral provinces, called alſo *audiences*, from the name of the tribunal to which they belong.

Audience is alſo the name of an eccleſiaſtical court held by the archbiſhop of Canterbury, wherein differences upon elections, conſecrations, inſtitutions, marriages, &c. are heard.

AUDIENDO & terminando, a writ, or rather a commiſſion to certain perſons, when any inſurrection or great riot is committed in any place, for the appeaſing and puniſhment thereof.

AUDIENTES, or Auditores, in *Church Hiſtory*, an order of catechumens; conſiſting of thoſe newly inſtructed in the myſteries of the Chriſtian religion, and not yet admitted to baptiſm.

AUDIT, a regular hearing and examination of an account by ſome proper officers, appointed for that purpoſe.

AUDITOR, in a general ſenſe, a hearer, or one who liſtens or attends to any thing.

Auditor, according to our *Law*, is an officer of the king, or ſome other great perſon, who, by examining yearly the accounts of the under officers, makes up a general book, with the difference between their receipts and charges, and their allowances to allocations.

Auditor of the Receipts, is an officer of the exchequer who files the tellers bills, makes an entry of them, and gives the lord treaſurer a certificate of the money received the week before. He alſo makes debentures to every teller, before they receive any money, and takes their accounts. He keeps the black book of receipts, and the treaſurer's key of the treaſury, and ſees every teller's money locked up in the new treaſury.

Auditors of the Revenue, or of the exchequer, officers who take the accounts of thoſe who collect the revenues and taxes raiſed by parliament, and take the accounts of the ſheriffs, eſcheators, collectors, tenants, and cuſtomers, and ſet them down in a book, and perfect them.

Auditors of the Preſt and Impreſt, officers of the exchequer, who take and make up the accounts of Ireland, Berwick, the mint, and of any money impreſſed to any man for the king's ſervice. They received poundage on all accounts paſſed by them, which amounted to a prodigious ſum, eſpecially in time of war. But the office is now aboliſhed, and 7000l. a-year given to the incumbents.

Auditors Collegiate, Conventual, &c. officers formerly appointed in colleges, &c. to examine and paſs their accounts.

AUDITORES, in *Church Hiſtory*. See Audientes.

The auditores formed one branch of the Manichean ſect, which was divided into *elect* and *auditors;* correſponding, according to ſome writers, to *clergy* and *laity;* and, according to others, to the *faithful* and *catechumens* among the Catholics. By the Manichean rule, a different courſe of life was preſcribed to the elect from that of the auditors. The latter might eat fleſh, drink wine, bathe, marry, traffic, poſſeſs eſtates, bear magiſtracy, and the like; all which things were forbidden to the elect. The auditors were obliged to maintain the elect, and kneeled down to aſk their bleſſing. Beauſobre obſerves, that the elect were eccleſiaſtics, and in general ſuch as made profeſſion of obſerving certain counſels, called *evangelic;* ſuch as the clergy and monks; and they were called the *perfect* by Theodoret. The auditors were the laity, and ſo denominated, becauſe they heard in the church, whilſt others taught and inſtructed.

Auditorium || Audran.

AUDITORIUM, in the ancient churches, was that part of the church where the audientes ſtood to hear and be inſtructed.

The auditorium was that part now called *navis eccleſiæ* *. In the primitive times, the church was ſo ſtrict in keeping the people together in that place, that the perſon who went from thence in ſermon-time was ordered by the council of Carthage to be excommunicated. * See *Nave*.

AUDITORY, ſomething relating to the ſenſe of hearing.

Auditory, or Audience, an aſſembly of people who attended to hear a perſon who ſpeaks in public.

Auditory is alſo uſed for the bench whereon a magiſtrate or judge hears cauſes.

Auditory, in *Ancient Churches*. See Auditorium.

Auditory Paſſage, (*meatus auditorius*), in *Anatomy;* the entrance of the ear. See Anatomy, *Index*.

Auditory Nerves. See Anatomy *Index*.

AUDRAN, Claude, a French engraver, the firſt of the celebrated artiſts of that name, was the ſon of Lewis Audran, an officer belonging to the wolf-hunters, in the reign of Henry IV. of France; and was born at Paris in 1592. He never made any great progreſs in that art; ſo that his prints are held in little or no eſtimation. Yet though he acquired no great reputation by his own works, it was no ſmall honour to him to be the father of three great artiſts, Germain, Claude, and Girard; the laſt of whom has immortalized the name of the family. Claude Audran retired from Paris to Lyons, where he reſided, and died in 1677.

Audran, *Carl*, a very eminent engraver, was brother to the preceding, though ſome aſſert he was only his couſin-german; and was born at Paris in 1594. In his infancy he diſcovered much taſte, and a great diſpoſition for the arts; and to perfect himſelf in engraving, which he appears to have been chiefly fond of, he went to Rome, where he produced ſeveral prints that did him great honour. At his return, he adopted that ſpecies of engraving which is performed with the graver only. He ſettled at Paris, where he died in 1674, without having ever been married. The Abbé Marolles, who always ſpeaks of this artiſt with great praiſe, attributes 130 prints to him: amongſt which, the *annunciation*, a middle-ſized plate, upright, from Hannibal Carracci; and the *aſſumption*, in a circle, from Domenichino, are the moſt eſteemed. In the early part of his life he marked his prints with C, or the name of Carl, till his brother Claude publiſhed ſome plates with the initial only of his baptiſmal

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tismal name; when, for distinction's sake, he used the letter K, or wrote his name Karl, with the K instead of the C.

Audran, *Germain*, the eldest son of Claude, mentioned in the preceding article but one, was born in 1631 at Lyons, where his parents then resided. Not content with the instructions of his father, he went to Paris, and perfected himself under his uncle Carl; so that, upon his return to Lyons, he published several prints which did great honour to his graver. His merit was in such estimation, that he was made a member of the academy established in that town, and chosen a professor. He died at Lyons in 1710, and left behind him four sons, all artists; namely, Claude, Benoist, John, and Louis.

Audran, *Claude*, the second of this name, and second son to Claude above-mentioned, was born at Lyons in 1639, and went to Rome to study painting; where he succeeded so well, that at his return he was employed by Le Brun to assist him in the battles of Alexander, which he was then painting for the king of France. He was received into the Royal Academy in the year 1675, and died unmarried at Paris in 1684. His virtues (says Abbé Fontenai) were as praiseworthy as his talents were great. M. Heineken mentions this artist as an engraver, without specifying any of his works in that line.

Audran, *Girard*, or *Gerard*, the most celebrated artist of the whole family of the Audrans, was the third son of Claude Audran mentioned in a preceding article, and born at Lyons in 1640. He learned from his father the first principles of design and engraving; and following the example of his brother, he left Lyons and went to Paris, where his genius soon began to manifest itself. His reputation there brought him to the knowledge of Le Brun, who employed him to engrave the *battles of Constantine*, and the *triumph* of that emperor; and for these works he obtained apartments at the Gobelins. At Rome, whither he went for improvement, he is said to have studied under Carlo Maratti, in order to perfect himself in drawing; and in that city, where he resided three years, he engraved several fine plates. M. Colbert, that great encourager of the arts, was so struck with the beauty of Audran's works whilst he resided at Rome, that he persuaded Louis XIV. to recal him. On his return, he applied himself assiduously to engraving; and was appointed engraver to the king, from whom he received great encouragement. In the year 1681 he was named counsellor of the Royal Academy; and died at Paris in 1703. He had been married; but left no male issue behind him.

Strutt's Dictionary.

The great excellency of this artist above that of any other engraver was, that though he drew admirably himself, yet he contracted no manner of his own; but transcribed on copper simply, with great truth and spirit, the style of the master whose pictures he copied. On viewing his prints you lose sight of the engraver, and naturally say, it is Le Brun, it is Poussin, it is Mignard, or it is Le Sueur, &c. as you turn to the prints which he engraved from those masters. Let any one examine the *battles* above-mentioned from Le Brun, the *preservation of the young Pyrrhus* from Nicholas Poussin, the *pest* from Mignard, and the *martyrdom of St Lawrence* from Le Sueur, and then judge candidly of the truth of this observation. The following judicious observations by the Abbe Fontenai, taken chiefly from M. Basan, with some small variation and additions, will fully illustrate the merits of Gerard Audran. "This sublime artist, far from conceiving that a servile arrangement of strokes, and the too frequently cold and affected clearness of the graver, were the great essentials of historical engraving, gave worth to his works by a bold mixture of free hatchings and dots, placed together apparently without order, but with an inimitable degree of taste; and has left to posterity most admirable examples of the style in which grand compositions ought to be treated. His greatest works, which have not a very flattering appearance to the ignorant eye, are the admiration of true connoisseurs and persons of fine taste. He acquired the most profound knowledge of the art by the constant attention and study which he bestowed upon the science of design, and the frequent use he made of painting from nature. This great man always knew how to penetrate into the genius of the painter he copied from; often improved upon, and sometimes even surpassed him. Without exception, he was the most celebrated engraver that ever existed in the historical line. We have several subjects which he engraved from his own designs, that manifested as much taste as character and facility. But, in the *battles of Alexander*, he surpassed even the expectations of Le Brun himself." These consist of three very large prints, lengthwise, each consisting of four plates, which join together, from Le Brun; namely, *the passage of the Granicus; the battle of Arbela; Porus brought to Alexander*, after his defeat. To this set are added two more large prints lengthwise, on two plates each, also from Le Brun, as follow: *Alexander entering the tent of Darius;* and *The triumphal entry of Alexander into Babylon*. The former was engraved by Gerard Edelink, and the latter by Gerard Audran. It is to be remarked of all these plates, that those impressions are generally most esteemed which have the name of Goyton the printer marked upon them. The *Pest*, from Peter Mignard, a large plate, lengthwise, also deserves particular notice. In the first impressions, the figure in the clouds is Juno with her peacock behind her; in the latter, the peacock is obliterated, and the wings of an angel are added to the figure.

Audran, *Benoit*, the second son of Germain Audran, was born at Lyons in 1661, where he learned the first principles of design and engraving under the instruction of his father. But soon after going to Paris, his uncle Gerard Audran took him under his tuition; and Benoit so greatly profited by his instructions, that though he never equalled the sublime style of his tutor, yet he deservedly acquired great reputation. Nay, the Abbé Fontenai adds this eulogium: "We admire in his works a share of those beauties which we find in the engravings of the illustrious Gerard." He was honoured with the appellation of the king's engraver, and received the royal pension. He was made an academician, and admitted into the council in 1715. He died unmarried at Louzouer, where he had an estate, in 1721. His manner was founded upon the bold clear style of his uncle. His outlines were firm and determined; his drawing correct; the heads of his figures are in general very expressive; and the

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the other extremities well marked. His works, when compared with thoſe of his uncle, appear to want that mellowneſs and harmony which are ſo conſpicuous in the latter; they are more dry; and the round dots with which he finiſhed his fleſh upon the lights are often too predominant. In his moſt finiſhed plates, we find the mechanical part of the engraving extremely neat, and managed with great taſte and judgment. Among his neateſt prints may be reckoned that which repreſents *Alexander ſick*, drinking from the cup which his phyſician preſents to him: a circular plate, from Le Sueur.

Audran, *John*, the third ſon of Germain Audran, was born at Lyons in 1667; and, after having received inſtructions from his father, went to Paris to perfect himſelf in the art of engraving under his uncle Gerard Audran. At the age of 20 years, the genius of this great artiſt began to diſplay itſelf in a ſurpriſing manner; and his future ſucceſs was ſuch, that in 1707, he obtained the title of engraver to the king, and had a penſion allowed him by his majeſty, with apartments in the Gobelins; and the following year he was made a member of the Royal Academy. He was 80 years of age before he quitted the graver; and near 90 when he died at his apartments aſſigned him by the king. He left three ſons behind him; one of whom was alſo an engraver, as we ſhall ſee below. "The moſt maſterly and beſt prints of this artiſt (in Mr Strutt's opinion) are thoſe which are not ſo pleaſing to the eye at firſt ſight. In theſe the etching conſtitutes a great part; and he has finiſhed them in a bold rough ſtyle. The ſcientific hand of the maſter appears in them on examination. The drawing of the human figure, where it is ſhown, is correct. The heads are expreſſive and finely finiſhed; the other extremities well marked. He has not, however, equalled his uncle. He wants that harmony in the effect; his lights are too much and too equally covered; and there is not ſufficient difference between the ſtyle in which he has engraved his back grounds and his draperies. This obſervation refers to a fine print by him of Athaliah, and ſuch as he engraved in that ſtyle. At other times he ſeems almoſt to have quitted the point, and ſubſtituted the graver. But here I think he has not ſo well ſucceeded. The effect is cold and ſilvery: ſee, for example, the *Andromache* from Sylveſtre. One of his beſt finiſhed prints, in this neat ſtyle, ſeems to me to be *Cupid* and *Pſyche* from Ant. Coypel."

Audran, *Louis*, the laſt ſon of Germain Audran, was born at Lyons in 1670; from whence he went to Paris, after the example of his brothers, to complete his ſtudies in the ſchool of his uncle Gerard. He died ſuddenly at Paris in 1712, before he had produced any great number of prints by his own hand. He aſſiſted, it is preſumed, his brothers in their more extenſive works. Among the moſt eſteemed prints by this artiſt are *the ſeven acts of mercy*, on ſeven middling ſized plates, lengthwiſe, from Sebaſtian Bourdon.

Audran, *Benoit*, the ſecond engraver of that name, was the ſon of John Audran, and nephew to the former Benoit: and was alſo eſtabliſhed at Paris. He engraved but a few plates. It is neceſſary, however, to be careful not to confound him with his uncle. But a little attention will eaſily prevent this miſtake; for the ſecond Benoit is vaſtly inferior to the firſt in point of merit. We have ſome few portraits by this artiſt; and among other plates, the *deſcent from the croſs*, from a picture of Pouſſin.

Aveiro || Avellino.

AVEIRO, a conſiderable city of Portugal, ſeated near the head of a ſmall gulf formed by the tide at the mouth of the river Vouga. This river forms a ſmall haven with a bar, over which veſſels may paſs that do not draw above eight or nine feet water. The city ſtands in a long plain well watered, and very fertile. This plain is nine miles broad, from Porto to Coimbra; and is bounded on the eaſt by a chain of mountains called *Sara d'Alcoba*, which reach from the one town to the other. Near this city there is ſalt made in ſufficient quantity to ſerve two or three provinces. Here is a remarkable nunnery, where none are received but the daughters of the ancient nobility. The inhabitants of Aveiro have the ſingular privilege, that no ſtranger whatever can paſs a night there without leave of the magiſtrate. W. Long. 9. 8. N. L. 40. 30.

AVELLANE, in *Heraldry*, a croſs, the quarters of which ſomewhat reſemble a filbert-nut. Sylvanus Morgan ſays, that it is the croſs which enſigns the mound of authority, or the ſovereign's globe.

AVELLINO, a city of Italy, in the kingdom of Naples, with a biſhop's ſee. It was almoſt ruined by an earthquake in 1694. It is, however, at preſent a pretty conſiderable place, extending a mile in length down the declivity of a hill, with ugly ſtreets, but tolerable houſes. The churches have nothing to recommend them, being crowded with monſtrous ornaments, in a barbarous ſtyle, which the Neapolitans ſeem to have borrowed from the Spaniards. The cathedral is a poor building, in a wretched ſituation, with little to attract the eye. The good people here need not run to Naples to ſee the blood of St Januarius: for they have a ſtatue of St Lawrence, with a phial of his blood, which for eight days in Auguſt entertains them with a ſimilar miraculous liquefaction. Their only edifice of note is a public granary, of the Compoſite order, adorned with antique ſtatues, and a very elegant bronze one of Charles II. of Spain, while a boy, caſt by Cavalier Coſimo. The number of inhabitants amounts to 8000, ſome ſay 10,000. The biſhop's revenue is about 6000 ducats (1125l.) a-year. The magiſtracy conſiſts of a Syndic and four Eletti, all annual; which offices are engroſſed by a certain number of families of ſome diſtinction, that neither intermarry nor aſſociate with the reſt of the burghers. There is a conſiderable manufacture of cloth here of various qualities and colours, but chiefly blue. Many wealthy merchants have a concern in this buſineſs, ſome with a capital of eighty thouſand ducats (15,000l.) The poor women who ſpin the wool muſt work very hard to earn above four grana a-day. The ſecond article of trade is maccaroni and paſte of many kinds, which being of an excellent quality, are in high repute all over the country. Wooden chairs are alſo made and ſold here in great quantities. Avellino abounds with proviſions of every ſort; each ſtreet is ſupplied with wholeſome water; the wine is but indifferent. The ſoil of this diſtrict, which conſiſts chiefly of volcanic ſubſtances, produces little corn, but fruit in abundance, of which the apple is deſervedly held in great eſteem. The moſt profitable, however, of all its fruit-trees is the hazel. Nut buſhes cover the face of the valley, and in

good

good years bring in a profit of ſixty thouſand ducats (11.250l.) The nuts are moſtly of the large round ſpecies of filbert, which we call *Spaniſh*. Theſe buſhes were originally imported into Italy from Pontus, and known among the Romans by the appellation of *Nux Pontica*, which in proceſs of time was changed into that of *Nux Avellana*, from the place where they had been propagated with the greateſt ſucceſs. The proprietors plant them in rows, and by dreſſing, form them into large buſhes of many ſtems. Every year they refreſh the roots with new earth, and prune off the ſtraggling ſhoots with great attention.

AVE-MARIA, the angel Gabriel's ſalutation of the Virgin Mary, when he brought her the tidings of the incarnation.—It is become a prayer or form of devotion in the Romiſh church. The chaplets and roſaries are divided into ſo many ave-marias, and ſo many pater-noſters, to which the Papiſts aſcribe a wonderful efficacy.

AVENA, OATS. See BOTANY *Index*.

AVENACEOUS, ſomething belonging to or partaking of the nature of oats.

AVENAGE, in *Law*, a certain quantity of oats paid by a tenant to a landlord, inſtead of rent or ſome other duties.

AVENCHE, an ancient city of Switzerland, in the canton of Bern, formerly the capital of all Switzerland, but now ſhows its former greatneſs only by its ruins. E. Long. 7. 7. N. Lat. 46. 50.

AVENES, a ſmall but ſtrong town in French Flanders, in the county of Hainault, ſeated on the river Theſpis. It contains about 2500 inhabitants; but the houſes are wrechedly built, and the ſtreets irregular. It was fortified by M. Vauban in a ſtrong regular manner. About this place is a prodigious number of white ſtones proper for building, and uſed by ſculptors for ſtatues: they are known by the name of *Stones of Avenes*. E. Long. 3. 40. N. Lat. 50. 10.

AVENIO, an ancient town of the Cavares, and one of the moſt opulent in Gallia Narbonenſis; now *Avignon*, in Provence. See AVIGNON.

AVENOR, an officer belonging to the king's ſtables, who provides oats for the horſes. He acts by warrant from the maſter of the horſe.

AVENS, in *Botany*. See CARIOPHYLLUS.

AVENTINE, JOHN, author of the Annals of Bavaria, was born of mean parentage, in the year 1466, at Abenſperg in the country juſt named. He ſtudied firſt at Ingolſtadt, and afterwards in the univerſity of Paris. In 1503, he privately taught eloquence and poetry at Vienna; and in 1507 he publicly taught Greek at Cracow in Poland. In 1509, he read lectures on ſome of Cicero's works at Ingoldſtadt: and in 1512, was appointed to be preceptor to Prince Louis and Prince Erneſt, ſons of Albert the Wiſe, duke of Bavaria, and travelled with the latter of theſe two princes. After this he undertook to write the annals of Bavaria; being encouraged by the dukes of that name, who ſettled a penſion upon him, and gave him hopes that they would defray the charges of the book. This work, which gained its author great reputation, was firſt publiſhed in 1554, by Jerome Zieglerus, profeſſor of poetry in the univerſity of Ingoldſtadt; and afterwards at Baſil in 1580, by Nicholas Ciſner. An affront which Aventine received in the year 1529, ſtuck by him all the reſt of his life: he was forcibly taken out of his ſiſter's houſe at Abenſperg, and hurried to jail; the true cauſe of which violence was never known: but it would probably have been carried to a much greater length, had not the duke of Bavaria interpoſed, and taken this learned man into his protection. Mr Bayle remarks, that the incurable melancholy which from this time poſſeſſed Aventine, was ſo far from determining him to lead a life of celibacy, as he had done till he was 64, that it induced him perhaps to think of marrying. The violence of his new paſſion was not, however, ſo great, but that it ſuffered him to adviſe with two of his friends, and conſult certain paſſages of the Bible relative to marriage, The reſult was, that it was beſt for him to marry; and having already loſt too much time, conſidering his age, he took the firſt woman he met with, who happened to be his own maid, ill-tempered, ugly, and extremely poor. He died in 1534, aged 68; leaving one daughter, who was then but two months old. He had a ſon, who died before.

AVENTINUS MONS, one of the ſeven hills on which ancient Rome ſtood. The origin of the name *Aventinus* is uncertain: but this hill was alſo called *Murcius*, from Murcia the goddeſs of ſloth, who had a little chapel there; and *Collis Dianæ*, from the temple of Diana; likewiſe *Remonius*, from Remus, who wanted to build the city, and who was buried there. It was taken within the compaſs of the city by Ancus Martius. To the eaſt it had the city walls; to the ſouth, the Campus Figulinus; to the weſt, the Tiber; and to the north, Mons Palatinus, in circuit two miles and a quarter.

AVENTURE, in *Law Books*, means a miſchance cauſing the death of a perſon without felony.

AVENUE, in *Gardening*, a walk planted on each ſide with trees, and leading to a houſe, garden-gate, wood, &c. and generally terminated by ſome diſtant object.

All avenues that lead to a houſe ought to be at leaſt as wide as the whole front of the houſe, if wider they are better ſtill; and avenues to woods and proſpects ought not to be leſs than 60 feet wide. The trees ſhould not be planted nearer to one another than 35 feet, eſpecially if they are trees of a ſpreading kind; and the ſame ought to be the diſtance, if they are for a regular grove.

The trees moſt proper for avenues with us, are the Engliſh elm, the lime, the horſe-cheſnut, the common cheſnut, the beech, and the abele. The Engliſh elm will do in all grounds, except ſuch as are very wet and ſhallow; and this is preferred to all other trees, becauſe it will bear cutting, heading, or lopping in any manner, better than moſt others. The rough or ſmooth Dutch elm is approved by ſome, becauſe of its quick growth. This is a tree which will bear removing very well; it is alſo green almoſt as ſoon as any plant whatever in ſpring, and continues ſo as long as any, and it makes an incomparable hedge, and is preferable to all other trees for lofty eſpaliers. The lime is valued for its natural growth and fine ſhade. The horſe-cheſnut is proper for all places that are not too much expoſed to rough winds. The common cheſnut will do very well in a good ſoil; and riſes to a conſiderable height, when planted ſomewhat cloſe; though, when it ſtands ſingle, it is rather inclined to ſpread than to grow tall.

The beech is a beautiful tree, and naturally grows well with us in its wild ſtate; but it is leſs to be choſen for avenues than the before-mentioned, becauſe it does not bear tranſplanting well, but is very ſubject to miſcarry. Laſtly, the abele is fit for any ſoil, and is the quickeſt grower of any foreſt-tree. It ſeldom fails in tranſplanting; and ſucceeds very well in wet ſoils, in which the others are apt to fail. The oak is but little uſed for avenues, becauſe of its ſlow growth.

The old method of planting avenues was with regular rows of trees, and this has been always kept to till of late: but we have now a much more magnificent way of planting avenues; this is by ſetting the trees in clumps, or platoons, making the opening much wider than before, and placing the clumps of trees at about 300 feet diſtant from one another. In each of theſe clumps there ſhould be planted either ſeven or nine trees; but it is to be obſerved, that this is only to be practiſed where the avenue is to be of ſome conſiderable length, for in ſhort walks this will not appear ſo ſightly as ſingle rows of trees. The avenues made by clumps are fitteſt of all for parks. The trees in each clump ſhould be planted about 30 feet aſunder; and a trench ſhould be thrown up round the whole clump, to prevent the deer from coming to the trees to bark them.

AVENZOAR, ABU MERWAN ABDALMALEC EBN ZOHR, an eminent Arabian phyſician, flouriſhed about the end of the eleventh or the beginning of the twelfth century. He was of noble deſcent, and born at Seville, the capital of Andaluſia, where he exerciſed his profeſſion with great reputation. His grandfather and father were both phyſicians. The large eſtate he inherited from his anceſtors, ſet him above practiſing altogether for gain: he therefore took no fees from the poor, or from artificers, though he refuſed not the preſents of princes and great men. His liberality was extended even to his enemies; for which reaſon he uſed to ſay, that they hated him not for any fault of his, but rather out of envy. Dr Freind writes, that he lived to the age of 135; that he began to practiſe at 40, or (as others ſay) at 20; and had the advantage of a longer experience than almoſt any one ever had, for he enjoyed perfect health to his laſt hour. He left a ſon, known alſo by the name of *Ebn Zohr*, who followed his father's profeſſion, was in great favour with Al Manzur emperor of Morocco, and wrote ſeveral treatiſes of phyſic.

Avenzoar was cotemporary with Averroes, who, according to Leo Africanus, heard the lectures of the former, and learned phyſic of him; this ſeems the more probable, becauſe Averroes more than once gives Avenzoar a very high and deſerved encomium, calling him *admirable, glorious, the treaſure of all knowledge,* and *the moſt ſupreme in phyſic from the time of Galen to his own.* Avenzoar, notwithſtanding, is by the generality of writers reckoned an empiric: But Dr Freind obſerves, that this character ſuits him leſs than any of the reſt of the Arabians. "He was bred," continues that author, "in a phyſical family, his father and grandfather being both practitioners, whom he always remembers with great gratitude and honour. We have his own teſtimony that he had a regular education; and that he not only learned what properly belongs to a phyſician, but, out of a great deſire of knowledge, every thing beſides which relates to pharmacy or ſurgery." Dr Freind afterwards obſerves, "that he was averſe to quackery, and rejects the idle ſuperſtitions of aſtrologers; and throughout all his works profeſſes himſelf ſo much of the dogmatical or rational ſect, which was directly oppoſite to the empirical, that he has a great deal of reaſoning about the cauſes and ſymptoms of diſtempers; and as in his theory he chiefly, if not only, follows Galen, ſo he quotes him upon all occaſions, oftener than the reſt of the Arabians do. Notwithſtanding he is ſo Galenical, there are ſeveral particulars in him which ſeldom or every occur in other authors; and there are ſome caſes which he relates from his own experience, which are worth peruſing." He wrote a book entitled, *Tayaſſir fi'lmadawât w'altadbir*, i. e. "The method of preparing medicines and diet;" which is much eſteemed. This work was tranſlated into Hebrew, in the year of Chriſt 1280, and thence into Latin by Paravicius, whoſe verſion has had ſeveral editions. The author added a ſupplement to it, under the title of *Jâmé*, or *a Collection*. He alſo wrote a treatiſe *Fi'ladwiyat wa'laughdiyat*, i. e. "Of Medicines and Food;" wherein he treats of their qualities.

AVERAGE, in *Commerce*, ſignifies the accidents and miſfortunes which happen to ſhips and their cargoes, from the time of their loading and ſailing to their return and unloading; and is divided into three kinds. 1. The ſimple or particular average, which conſiſts in the extraordinary expences incurred for the ſhip alone, or for the merchandiſes alone. Such is the loſs of anchors, maſts, and rigging, occaſioned by the common accidents at ſea; the damages which happen to merchants by ſtorm, prize, ſhipwreck, wet, or rotting; all which muſt be borne and paid by the thing which ſuffered the damage. 2. The large and common average, being thoſe expences incurred, and damages ſuſtained, for the common good and ſecurity both of the merchandiſes and veſſels, conſequently to be borne by the ſhip and cargo, and to be regulated upon the whole. Of this number are the goods or money given for the ranſom of the ſhip and cargo, things thrown overboard for the ſafety of the ſhip, the expences for unloading for entering into a river or harbour, and the proviſions and hire of the ſailors when the ſhip is put under an embargo. 3. The ſmall averages, which are the expences for towing and piloting the ſhip out of or into harbours, creeks, or rivers, one third of which muſt be charged to the ſhip, and two thirds to the cargo.

AVERAGE is more particularly uſed for a certain contribution that merchants make proportionably to their loſſes, who have had their goods caſt into the ſea in the time of a tempeſt. It alſo ſignifies a ſmall duty which thoſe merchants, who ſend goods in another man's ſhip, pay to the maſter for his care of them over and above the freight. Hence it is expreſſed in the bills of lading, paying ſo much freight for the ſaid goods, with primage and average accuſtomed.

AVERDUPOIS. See AVOIRDUPOIS.

AVERNUS, a lake of Campania in Italy, near Baiæ, famous among the ancients for its poiſonous qualities. It is deſcribed by Strabo as lying within the Lucrine bay, deep and darkſome, ſurrounded with ſteep banks that hang threatening over it, and only acceſſible

accessible by the narrow passage through which you sail in. Black aged groves stretched their boughs over the watery abyss, and with impenetrable foliage excluded almost every ray of wholesome light; mephitic vapours ascending from the hot bowels of the earth, being denied free passage to the upper atmosphere, floated along the surface in poisonous mists. These circumstances produced horrors fit for such gloomy deities; a colony of Cimmerians, as well suited to the rites as the place itself, cut dwellings in the bosom of the surrounding hills, and officiated as priests of Tartarus. Superstition always delighting in dark ideas, early and eagerly seized upon this spot, and hither she led her trembling votaries to celebrate her dismal orgies; here she evoked the manes of departed heroes—here she offered sacrifices to the gods of hell, and attempted to dive into the secrets of futurity. Poets enlarged upon the popular theme, and painted its awful scenery with the strongest colours of their art. Homer brings Ulysses to Avernus, as to the mouth of the infernal abodes; and in imitation of the Grecian bard, Virgil conducts his hero to the same ground. Whoever sailed thither, first did sacrifice; and endeavoured to propitiate the infernal powers, with the assistance of some priests who attended upon the place, and directed the mystic performance. Within, a fountain of pure water broke out just over the sea, which was fancied to be a vein of the river Styx; near this fountain was the oracle: and the hot waters frequent in those parts were supposed to be branches of the burning Phlegethon. The poisonous effluvia from this lake were said to be so strong, that they proved fatal to birds endeavouring to fly over it. Virgil ascribes the exhalation not to the lake itself, but to the cavern near it, which was called *Avernus* or *Cave of the Sibyl*, and through which the poets feigned a descent to hell. Hence the proper name of the lake is *Lacus Averni*, the "lake near the cavern," as it is called by some ancient authors.

The holiness of these shades remained unimpeached for many ages: Hannibal marched his army to offer incense at this altar; but it may be suspected he was led to this act of devotion rather by the hopes of surprising the garrison of Puteoli, than by his piety. After a long reign of undisturbed gloom and celebrity, a sudden glare of light was let in upon Avernus; the horrors were dispelled, and with them vanished the sanctity of the lake: the axe of Agrippa brought its forest to the ground, disturbed its sleepy waters with ships, and gave room for all its malignant effluvia to escape. The virulence of these exhalations, as described by ancient authors, has appeared so very extraordinary, that modern writers, who know the place in a cleared state only, charge these accounts with exaggeration: but Mr Swinburn thinks them entitled to more respect; for even now, he observes the air is feverish and dangerous, as the jaundiced faces of the vine-dressers, who have succeeded the Sibyls and the Cimmerians in the possession of the temple, most ruefully testify. Boccacio relates, that, during his residence at the Neapolitan court, the surface of this lake was suddenly covered with dead fish, black and singed, as if killed by some subaqueous eruption of fire.

At present the lake abounds with tench; the Lucrine with eels. The change of fortune in these lakes is singular: In the splendid days of imperial Rome the Lucrine was the chosen spot for the brilliant parties of pleasure of a voluptuous court: now, a slimy bed of rushes covers the scattered pools of this once beautiful sheet of water; while the once dusky Avernus is clear and serene, offering a most alluring surface and charming scene for similar amusements. Opposite to the temple is a cave usually styled the Sibyl's grotto; but apparently more likely to have been the mouth of a communication between Cuma and Avernus, than the abode of a prophetess; especially as the Sibyl is positively said by historians to have dwelt in a cavern under the Cumean citadel.

AVERRHOA. See Botany *Index*.

AVERROES, one of the most subtile philosophers that ever appeared among the Arabians, flourished at the end of the 11th and beginning of the 12th century. He was the son of the high-priest and chief judge of Corduba in Spain: he was educated in the university of Morocco; and studied natural philosophy, medicine, mathematics, law, and divinity. After the death of his father, he enjoyed his posts; but notwithstanding his being exceeding rich, his liberality to men of letters in necessity, whether they were his friends or his enemies, made him always in debt. He was afterwards stripped of all his posts, and thrown into prison, for heresy; but the oppressions of the judge who succeeded him, caused him to be restored to his former employments.

He died at Morocco in the year 1206. He was excessively fat, though he ate but once a day. He spent all his nights in the study of philosophy; and when he was fatigued, amused himself with reading poetry or history. He was never seen to play at any game, or to partake in any diversion. He was extremely fond of Aristotle's works, and wrote commentaries on them; whence he was styled, *the commentator*, by way of eminence. He likewise wrote a work on the whole art of physic, and many amorous verses; but when he grew old, he threw these last into the fire. His other poems are lost, except a small piece, in which he says, "That when he was young, he acted against his reason; but that when he was in years, he followed its dictates:" upon which he utters this wish; "Would to God I had been born old, and that in my youth I had been in a state of perfection!" As to religion, his opinions were, that Christianity is absurd; Judaism, the religion of children; Mahometanism, the religion of swine.

AVERROISTS, a sect of peripatetic philosophers, who appeared in Italy some time before the restoration of learning, and attacked the immortality of the soul. They took their denomination from Averroes, the celebrated interpreter of Aristotle (see the preceding article), from whom they borrowed their distinguishing doctrine.

The Averroists, who held the soul was mortal, according to reason or philosophy, yet pretended to submit to the Christian theology, which declares it immortal. But the distinction was held suspicious; and this divorce of faith from reason was rejected by the doctors of that time, and condemned by the last council of the Lateran under Leo X.

AVERRUNCI (dei); certain gods, whose business it was, according to the Pagan theology, to avert misfortunes.

fortunes. Apollo and Hercules were of the number of these gods among the Greeks; and Castor and Pollux among the Romans.

AVERSA, a town of Italy in the kingdom of Naples, with a bishop's see. It is situated in a very fine plain, in E. Long. 14. 20. N. Lat. 41. 0.

AVERSION, according to Lord Kames, is opposed to *affection*, and not to *desire*, as it commonly is. We have an affection to one person; we have an aversion to another; the former disposes us to do good to its object, the latter to do ill.

AVERTI, in *Horsemanship*, is applied to a regular step or motion enjoined in the lessons. In this sense they say *pas averte*, sometimes *pas ecouté*, and *pas d'ecole*, which all denote the same. The word is mere French, and signifies *advised*.

AVES, one of the Carribbee islands, 451 miles south of Porto Rico, with a good harbour for careening of ships. It is so called from the great number of birds that frequent it. There is another of the same name lying to the northward of this, in N. Lat. 15. 0.; and a third near the eastern coast of Newfoundland, in N. Lat. 50. 5.

Aves, *Birds*, the name of Linnæus's second class of animals. See Ornithology.

AVESBURY, Robert, an English historian, of whom little more is known than that he was keeper of the registery of the court of Canterbury in the reign of Edward III. and consequently that he lived in the 14th century. He wrote, *Memorabilia gesta magnifici regis Angliæ domini Edwardi tertii post conquestum, procerumque; tactis primitus quibusdam gestis de tempore patris sui domini Edwardi secundi, quæ in regnis Angliæ, Scotiæ, et Franciæ, ac in Aquitania et Britannia, non humana sed Dei potentia, contigerunt, per Robertum de Avesbury.* This history ends with the battle of Poictiers, about the year 1356. It continued in manuscript till the year 1720, when it was printed by the industrious Thomas Hearne at Oxford, from a manuscript belonging to Sir Thomas Seabright. It is now become very scarce.

AVEZZANO, a town of Italy in the kingdom of Naples in the Farther Abruzzo. It is built on an almost imperceptible declivity, one mile from the lake of Celano, to which an avenue of poplars leads from the baronial castle. This edifice stands at a little distance from the town, is square, and flanked with towers; it was erected by Virginio Orsini, to which family this and many other great lordships belonged, before they were wrested from them in times of civil war, and transferred to the Colonnas. Avezzano was founded in 860, and contains 2700 inhabitants, and two religious communities within its walls, which are indeed in a ruinous condition. The houses are in general mean; but there are some large buildings and opulent families of the class of gentlemen, not possessed of fees held *in capite*.

AUGE, a territory of Normandy in France, which gives title to a viscount. It extends from Falaise and Argenton as far as the sea, between the rivers Dives, Vie, and Tongues. The arable land is stiff, and produces but little good corn: but they sow sainfoin; which succeeds so well that they have five good crops successively: they likewise sow flax and hemp; and have a vast quantity of apples, with which they make cyder. Horses are bred here in great numbers; and the inhabitants fatten the oxen which come from Poictou and Britanny.

AUGEAS, in *Fabulous History*, was king of Elis, and particularly famed for his stable, which contained 3000 oxen, and had not been cleaned for 30 years. Hercules was desired to clear away the filth from this stable in one day; and Augeas promised, if he performed it, to give him a tenth part of the cattle. This task Hercules is said to have executed by turning the course of the river Alpheus through the stable; when Augeas refusing to stand by his engagement, Hercules slew him with his arrows, and gave his kingdom to Phyleus his son, who had shown an abhorrence of his father's insincerity.

AUGMENT, in *Grammar*, an accident of certain tenses of Greek verbs, being either the prefixing of a syllable, or an increase of the quantity of the initial vowels.

AUGMENTATION, in a general sense, is the act of adding or joining something to another with a design to render it large.

Augmentation is also used for the additament or thing added.

Augmentation was also the name of a court erected 27 Hen. VIII. so called from the augmentation of the revenues of the crown, by the suppression of religious houses; and the office still remains, wherein there are many curious records, though the court has been dissolved long since.

Augmentation, in *Heraldry*, are additional charges to a coat-armour, frequently given as particular marks of honour, and generally borne either in the escutcheon or a conton; as have all the baronets of England, who have borne the arms of the province of Ulster in Ireland.

AUGRE, or Awgre, an instrument used by carpenters and joiners to bore large round holes; and consisting of a wooden handle, and an iron blade terminated at bottom with a steel bit.

AUGSBURG, a city of Germany, capital of the circle of Suabia, seated near the confluence of the Ardech and Lech, in one of the most beautiful plains that can be imagined. It is one of the largest and handsomest cities of the empire; but the fortifications are after the old manner, and very irregular; the streets are broad and straight; the houses mostly of timber, plastered and whitened without, or adorned with paintings; the rest are of freestone; the churches and fountains are generally ornamented with fine figures of brass. Many of the churches are stately, and adorned within with curious workmanship and paintings. That part of the city erected by the noble family of the Fuggers, who are lords of the adjacent country, consists of several streets crosswise, containing 106 houses: the poor people that inhabit them are maintained by an annual pension. Its magnificent town-house is little inferior to that of Amsterdam, it being a vast square stone building, with a marble portico; at the top of the front, within the pediment, is a large spread eagle, holding a sceptre and globe in its talons, of brass gilt, said to weigh 2200 weight; the great portal is of a very beautiful reddish marble, over which is a balcony of the same colour, supported by two pillars of white marble; over the gate there are two large griffins of brass;

Augſburg. braſs; moſt of the rooms are wainſcotted and ceiled with very fine timber: the great hall is very magnificent, and paved with marble; it is 110 feet long, 58 broad, and 52 high, and its roof is ſupported by eight columns of red marble; the ceiling of the upper wall is of very curious workmanſhip of poliſhed aſh, conſiſting of compartments, the ſquares and pannels of which are enriched with gilded ſculptures, and filled with pictures and other ornaments; this is likewiſe ſupported by eight pillars with baſes and chapiters of braſs: the other rooms are handſomely adorned with very fine paintings.

In the ſquare, near the town-houſe, is the fountain of Auguſtus, which is a marble baſon, ſurrounded with iron balluſtrades finely wrought: at the four corners are four braſs ſtatues as big as the life, two of which are women and two men; in the middle of the baſon is a pedeſtal, at the foot of which are four large ſphinxes ſquirting water out of their breaſts; a little above theſe are four infants holding four dolphins in their arms, which pour water out of their mouths; and over theſe infants are feſtoons and pine-apples all of braſs; upon the pedeſtal is the ſtatue of Auguſtus as large as the life. The fountain moſt remarkable next to this is that of Hercules, which is a hexagon baſon with ſeveral braſs figures, particularly Hercules engaging the hydra. Another curioſity is the ſecret gate, which was contrived to let in perſons ſafely in time of war: it has ſo many engines and diviſions with gates and keys, and apartments for guards at ſome diſtance from each other, where paſſengers are examined, that it is impoſſible for the town to be ſurpriſed this way; the gates are bolted and unbolted, opened and ſhut, by unſeen operators, inſomuch that it looks like enchantment. The water-towers are alſo very curious, of which there are three ſeated on a branch of the river Lech, which runs through the city in ſuch a torrent as to drive many mills, which work a number of pumps that raiſe the water in large leaden pipes to the tops of the towers; one of theſe ſends water to the public fountains, and the reſt to near 1000 houſes in the city.

The Lutherans have a college here, which is a vaſt ſquare building, with a fine clock on the top of the front. In this there are ſeven different claſſes, a hall for public diſputations, and a theatre for dramatic repreſentations. The cathedral is a large, gloomy, Gothic building, with two ſpire ſteeples; it is adorned with paintings upon whimſical ſubjects, and has a great gate all of braſs, over which are ſeveral ſcripture paſſages well repreſented in baſſo-relievo. The Jeſuits had a ſplendid college here, with a church full of gilding, painting, and carving; and a fine library. Though half the inhabitants are Lutherans, there are a great many Popiſh proceſſions. There are no Jews in the town, nor are they ſuffered to lie there; but they inhabit a village at about a league diſtance, and pay ſo much an hour for the liberty of trading in the daytime. The Benedictine abbey is a vaſt Gothic building, the ceiling of which is ſaid to be the higheſt in Germany, and overlooks all the reſt of the churches; it is adorned with ſeveral ſtatues, and has one very grand altar. The church of St Croix is one of the handſomeſt in Augſburg for architecture, painting, ſculpture, gilding, and a fine ſpire.

The inhabitants look upon Auguſtus Cæſar as the founder of the town: it is true, that that emperor ſent Augſburg. a colony there; but the town was already founded, though he gave it the name of *Auguſta Vindelicorum*. Augſburg, indeed, is one of the oldeſt towns in Germany, and one of the moſt remarkable of them, as it is there and at Nuremberg that you meet with the oldeſt marks of German art and induſtry. In the 14th and 15th centuries, the commerce of this town was the moſt extenſive of any part of ſouth Germany, and contributed much to the civilization of the country by the works of art and variety of neceſſaries to the comfort and convenience of life which it was the means of introducing. Many things originated in this town which have had a great influence on the happineſs of mankind. Not to mention the many important diets of the empire held here; here, in 952, did a council confirm the order for the celibacy of prieſts; here, in 1530, was the confeſſion of faith of the Proteſtants laid before the emperor and other eſtates of Germany; and here, in 1555, was ſigned the famous treaty of peace, by which religious liberty was ſecured to Germany.

Though the Proteſtants were very powerful at Augſburg, they could not keep their ground: for the Bavarians drove them from thence: but Guſtavus Adolphus reſtored them again in 1632; ſince which time they have continued there, and ſhare the government with the Catholics. In 1703, the elector of Bavaria took the city after a ſiege of ſeven days, and demoliſhed the fortifications: however the battle of Hochſtedt reſtored their liberty, which they yet enjoy under the government of their own magiſtrates, the biſhop having no temporal dominion in the city. The chapter is compoſed of perſons of quality, who are to bring proofs of their nobility. The canons have a right of electing their own biſhop, who is a ſovereign, in the ſame manner as ſeveral of the German biſhops.

The police of the place is very good: and though the town has no territory, it has no debts. Augſburg is, however, no longer what it was. It no longer has a Fugger and a Welſer in it to lend the emperor millions. In this large and handſome town, formerly one of the greateſt trading towns in Germany, there are no merchants at preſent to be found who have capitals of more than 20,000l. The others, moſt of whom muſt have their coaches, go creeping on with capitals of 3000l. or 4000l. and do the buſineſs of brokers and commiſſioners. Some houſes, however, carry on a little banking trade; and the way through Tyrol and Graubundten occaſions ſome little exchange between this place and Germany. After theſe brokers and and doers of buſineſs by commiſſion, the engravers, ſtatuaries, and painters, are the moſt reputable of the labouring part of the city. Their productions, like the toys of Nuremberg, go everywhere. There are always ſome people of genius amongſt them; but the ſmall demand for their art affords them ſo little encouragement, that to prevent ſtarving they are moſtly confined to the ſmall religious works which are done elſewhere by Capuchin monks. They furniſh all Germany with little pictures for prayer books, and to hang in the citizens houſes. There is an academy of arts inſtituted here under the protection of the magiſtrates: the principal aim of which is to produce good mechanics, and preſerve the manufactures of the city.

This

This town, which is 9½ miles in circumference, contains, according to Mr Riefbeck, hardly 30,000 inhabitants: but Mr Nicolai makes them about 35,000.

This city has its drinking water from the river Lech, which runs at fome diftance from it; and the aqueducts which convey the water are much to be admired. As the court of Bavaria has it in its power to cut off this indifpenfable neceffary, by threatening the town with doing fo, it often lays it under contribution. But as it has, befides this, other means of keeping the high council in a ftate of dependence, to fecure itfelf from this oppreffion, the city feeks the emperor's protection, upon whom it makes itfelf as dependent on the other fide, fo as to be indeed only a ball which both courts play with. The emperor's minifter to the circle of Suabia generally refides here, and by fo doing fecures to his court a perpetual influence. There are always Auftrian and Pruffian recruiting parties quartered here, and the partiality of the government to the former is very remarkable. In the war of 1756, the citizens were divided into equal parties for the two courts. The Catholics confidered the emperor as their god, and the Proteftants did the fame by the king of Pruffia. The flame of religion had almoft kindled a bloody civil war amongft them.—The bifhop takes his name from this town, but refides at Dillingen. He has an income of about 20,000l. *per annum*. As a proof of the catholicifm of this place, the Pope throughout his whole progrefs met nowhere with fuch honours as he did here. This he owed to his friends the Jefuits, who have ftill great influence. E. Long. 10. 58. N. Lat. 48. 24.

Augsburg Confeffion, denotes a celebrated confeffion of faith drawn up by Luther and Melancthon, on behalf of themfelves and other ancient reformers, and prefented in 1530 to the emperor Charles V. at the diet of Augufta or Augfburg, in the name of the evangelic body. This confeffion contains 28 chapters; of which the greateft part is employed in reprefenting, with perfpicuity and truth, the religious opinions of the Proteftants, and the reft in pointing out the errors and abufes that occafioned their feparation from the church of Rome.

AUGUR, an officer among the Romans appointed to foretel future events, by the chattering, flight, and feeding of birds. There was a college or community of them, confifting originally of three members with refpect to the three tribes, the Luceres, Ramnenfes, and Tatienfes: afterwards the number was increafed to nine, four of whom were patricians and five plebeians. They bore an augural ftaff or wand, as the enfign of their authority; and their dignity was fo much refpected, that they were never depofed, or any fubftituted in their place, though they fhould be convicted of the moft enormous crimes. See Augury.

AUGURAL, fomething relating to the augurs.—The augural inftruments are reprefented on feveral ancient medals.

Augural Supper, that given by a prieft on his firft admiffion into the order, called alfo by Varro *Adjicialis*.

Augural Books, thofe wherein the difcipline and rules of augury were laid down.

AUGURALE, the place in a camp where the general took aufpicia. This anfwered to the *Auguratorium* in the city.

Augurale is alfo ufed in Seneca for the enfign or badge of an augur, as the *lituus*.

AUGURATORIUM, a building on the Palatine mount, where public auguries were taken.

AUGURY, in its proper fenfe, the art of foretelling future events by obfervations taken from the chattering, finging, feeding, and flight, of birds; though it is ufed by fome writers in a more general fignification, as comprifing all the different kinds of divination.

Augury was a very ancient fuperftition. We know from Hefiod, that hufbandry was in part regulated by the coming or going of birds: and moft probably it had been in ufe long before his time, as aftronomy was then in its infancy. In procefs of time, thefe animals feem to have gained a greater and very wonderful authority, till at laft no affair of confequence, either of private or public concern, was undertaken without confulting them. They were looked upon as the interpreters of the gods; and thofe who were qualified to underftand their oracles were held among the chief men in the Greek and Roman ftates, and became the affeffors of kings, and even of Jupiter himfelf. However abfurd fuch an inftitution as a college of augurs may appear in our eyes, yet, like all other extravagant inftitutions, it had in part its origin from nature. When men confidered the wonderful migration of birds, how they difappeared at once, and appeared again at ftated times, and could give no guefs where they went, it was almoft natural to fuppofe, that they retired fomewhere out of the fphere of this earth, and perhaps approached the ethereal regions, where they might converfe with the gods, and thence be enabled to predict events. It was almoft natural for a fuperftitious people to imagine this; at leaft to believe it, as foon as fome impoftor was impudent enough to affert it. Add to this, that the difpofition in fome birds to imitate the human voice, muft contribute much to the confirmation of fuch a doctrine. This inftitution of augury feems to have been much more ancient than that of arufpicy; for we find many inftances of the former in Homer, but not a fingle one of the latter, though frequent mention is made of facrifices in that author. From the whole of what has been obferved, it feems probable that natural augury gave rife to religious augury, and this to arufpicy, as the mind of man makes a very eafy tranfition from a little truth to a great deal of error.

A paffage in Ariftophanes gave the hint for thefe obfervations. In the comedy of the Birds, he makes one of them fay this: ‘ The greateft bleffings which can happen to you, mortals, are derived from us; firft we fhow you the feafons, viz. fpring, winter, autumn. The crane points out the time for fowing, when fhe flies with her warning notes into Egypt; fhe bids the failor hang up his rudder and take his reft, and every prudent man provide himfelf with winter garments. Next the kite appearing, proclaims another feafon, viz. when it is time to fhear his fheep. After that the fwallow informs you when it is time to put on fummer clothes. We are to you, (adds the chorus), Ammon, Dodona, Apollo: for, after confulting us, you undertake every thing; merchandife, purchafes, marriages,

marriages, &c.' Now, it ſeems not improbable, that the ſame tranſition was made in the ſpeculations of men which appears in the poet's words; and that they were eaſily induced to think, that the ſurpriſing foreſight of birds, as to the time of migration, indicated ſomething of a divine nature in them; which opinion Virgil, as an Epicurean, thinks fit to enter his proteſt againſt, when he ſays,

> *Haud equidem credo, quia ſit divinitas illis*
> *Ingenium.*

But to return to Ariſtophanes. The firſt part of the chorus, from whence the fore-cited paſſage is taken, ſeems, with all its wildneſs, to contain the fabulous cant, which the augurs made uſe of in order to account for their impudent impoſitions on mankind. It ſets out with a coſmogony; and ſays, That in the beginning were Chaos and Night, and Erebus and Tartarus: That there was neither water, nor air, nor ſky: That Night laid an egg, from whence, after a time, Love aroſe: That Love, in conjunction with Erebus, produced a third kind; and that they were the firſt of the immortal race, &c.

AUGUST, (*auguſtus*), in a general ſenſe, ſomething majeſtic, venerable, or ſacred. The appellation was firſt conferred by the Roman ſenate upon Octavius, after his being confirmed by them in the ſovereign power. It was conceived as expreſſing ſomething divine, or elevated above the pitch of mankind, being derived from the verb *augeo*, "I increaſe," *tanquam ſupra humanam ſortem auctus*. See AUGUSTUS.

AUGUST, in *Chronology*, the eighth month of our year, containing 31 days. Auguſt was dedicated to the honour of Auguſtus Cæſar, becauſe, in the ſame month, he was created conſul, thrice triumphed in Rome, ſubdued Egypt to the Roman empire, and made an end of civil wars, being before called *Sextilis*, or the ſixth month from March.

AUGUSTA, or AUSTA, an iſland in the Adriatic ſea on the coaſt of Dalmatia, near Raguſa, ſubject to Venice. E. Long. 17. 50. N. Lat. 42. 35.

AUGUSTA, a town of Georgia in North America. See GEORGIA.

AUGUSTA Auſciorum, a town of Aquitania, ſo named out of compliment to Auguſtus, being originally called *Climberrum*, which name it afterwards reſumed. In the middle age, it took the name of the people, *Auſci*; and is now called *Auch*, the capital of Gaſcony.

AUGUSTA Emerita, a town of Luſitania on the river Anas, the capital of the province; a colony of the Emeriti, or ſuch ſoldiers as had ſerved out their legal time, were men of experience, or had received marks of favour. The colony was founded by Auguſtus: and is now called *Merida*, a city of Spain, in Eſtremadura, on the river Guadiana. See MERIDA.

AUGUSTA Prætoria, a town and colony of Gallia Ciſalpina, and capital of the Salaſſi; ſeated at the foot of the Alpes Graiæ, on the Duria. Now *Aouſte* in Piedmont. See AOUSTE.

AUGUSTA Rauracorum, a town of Gallia Belgica; now a ſmall village called *Auguſt*, at the bend of the Rhine northwards, but from the ruins, which are ſtill to be ſeen, appears to have been a conſiderable colony, at the diſtance of ſix miles from Baſil to the eaſt.

AUGUSTA Sueſſonum, a town of Gallia Belgica on the Axona; ſo called from Auguſtus, and with great probability ſuppoſed to be the Noviodunum Sueſſonum of Cæſar. Now *Soiſſons*, on the river Aiſne, in the Iſle of France. See SOISSONS.

AUGUSTA Taurinorum, a town of the Taurini at the foot of the Alps, where the Duria Minor falls into the Po; now *Turin*, the capital of Piedmont.

AUGUSTA Treba, a town of the Æqui, near the ſpring of the river Anio in Italy; now *Trevi*, in Umbria, or in the eaſt of the Campagna di Roma.

AUGUSTA Trevirorum, a town of the Treviri, a people inhabiting between the Rhine and the Meuſe, but eſpecially about the Moſelle; now *Triers*, or *Treves*, in the circle of the Lower Rhine, on the Moſelle.

AUGUSTA Vindelicornm, a town of the Licates on the Licus; called by Tacitus a noble colony of *Rhætia*; now *Augsburg*, capital of Suabia.

AUGUSTA Hiſtoria, is the hiſtory of the Roman emperors from the time of Adrian to Carinus, that is, from the year of our Lord 157 to 285, compoſed by ſix Latin writers, Æl. Spartianus, Julius Capitolinus, Æl. Lampridius, Vulcatius Gallicanus, Trebellius Pollio, and Flavius Vopiſcus.

AUGUSTALES, in *Roman Antiquity*, an epithet given to the flamens or prieſts appointed to ſacrifice to Auguſtus after his deification; and alſo to the ludi or games celebrated in honour of the ſame prince on the fourth of the ides of October.

AUGUSTALIA, a feſtival inſtituted by the Romans in honour of Auguſtus Cæſar, on his return to Rome, after having ſettled peace in Sicily, Greece, Syria, Aſia, and Parthia; on which occaſion they likewiſe built an altar to him, inſcribed *Fortunæ reduci*.

AUGUSTALIS PRÆFECTUS, a title peculiar to a Roman magiſtrate who governed Egypt, with a power much like that of a proconſul in other provinces.

AUGUSTAN CONFESSION. See *Augsburg Confeſſion*.

AUGUSTIN, or AUSTIN, ST, the firſt archbiſhop of Canterbury, was originally a monk in the convent of St Andrew at Rome, and educated under St Gregory, afterwards Pope Gregory I. by whom he was deſpatched into Britain with 40 other monks of the ſame order, about the year 596, to convert the Engliſh Saxons to Chriſtianity. They landed in the iſle of Thanet; and having ſent ſome French interpreters to King Ethelbert with an account of their errand, the king gave them leave to convert as many of his ſubjects as they could, and aſſigned their place of reſidence, at Dorovernum, ſince called *Canterbury*; to which they were confined till the king himſelf was converted, whoſe example had a powerful influence in promoting the converſion of his ſubjects; but though he was extremely pleaſed at their becoming Chriſtians, he never attempted to compel them. He deſpatched a prieſt and a monk to Rome, to acquaint the pope with the ſucceſs of his miſſion, and to deſire his reſolution of certain queſtions. Theſe men brought back with them a pall, and ſeveral books, veſtments, utenſils, and ornaments for the churches. His holineſs, by the ſame meſſengers,

meſſengers, gave Auguſtin directions concerning the ſettling of epiſcopal ſees in Britain; and ordered him not to pull down the idol-temples, but to convert them into Chriſtian churches; only deſtroying the idols, and ſprinkling the place with holy water, that the natives, by frequenting the temples they had been always accuſtomed to, might be the leſs ſhocked at their entrance into Chriſtianity. Auguſtin reſided principally at Canterbury, which thus became the metropolitan church of England; and having eſtabliſhed biſhops in ſeveral of the cities, he died on the 26th May, 607. The Popiſh writers aſcribe ſeveral miracles to him. The obſervation of the feſtival of St Auguſtin was firſt enjoined in a ſynod held under Cuthbert archbiſhop of Canterbury, and afterwards by the pope's bull in the reign of King Edward III.

AUGUSTINE, St, an illuſtrious father of the church, was born at Thagaſte, a city of Numidia, on the 13th of November 354. His father, a burgeſs of that city, was called *Patricius;* and his mother, *Monica*, who being a woman of great virtue, inſtructed him in the principles of the Chriſtian religion. In his early youth he was in the rank of the catechumens; and falling dangerouſly ill, earneſtly deſired to be baptized; but the violence of the diſtemper ceaſing, his baptiſm was delayed. His father, who was not yet baptized, made him ſtudy at Thagaſte, Madaura, and afterwards at Carthage. Auguſtine having read Cicero's books of philoſophy, began to entertain a love for wiſdom, and applied himſelf to the ſtudy of the Holy Scriptures; nevertheleſs, he ſuffered himſelf to be ſeduced by the Manicheans. At the age of 19, he returned to Thagaſte, and taught grammar, and alſo frequented the bar: he afterwards taught rhetoric at Carthage with applauſe. The inſolence of the ſcholars at Carthage made him take a reſolution to go to Rome, though againſt his mother's will. Here alſo he had many ſcholars; but diſliking them, he quitted Rome, and ſettled at Milan, and was choſen public profeſſor of rhetoric in that city. Here he had opportunities of hearing the ſermons of St Ambroſe, which, together with the ſtudy of St Paul's epiſtles, and the converſion of two of his friends, determined him to retract his errors, and quit the ſect of the Manicheans; this was in the 32d year of his age. In the vacation of the year 386, he retired to the houſe of a friend of his, named *Verecundus*, where he ſeriouſly applied himſelf to the ſtudy of the Chriſtian religion, in order to prepare himſelf for baptiſm, which he received at Eaſter in the year 387. Soon after this, his mother came to ſee him at Milan, and invite him back to Carthage; but at Oſtia, whither he went to embark in order to his return, ſhe died. He arrived in Africa about the end of the year 388; and having obtained a garden-plot without the walls of the city of Hippo, he aſſociated himſelf with 11 other perſons of eminent ſanctity, who diſtinguiſhed themſelves by wearing leathern girdles, and lived there in a monaſtic way for the ſpace of three years, exerciſing themſelves in faſting, prayer, ſtudy, and meditation, day and night: from hence ſprung up the Auguſtine friars, or eremites of St Auguſtine, being the firſt order of mendicants; thoſe of St Jerome, the Carmelites, and others, being but branches of this of St Auguſtine. About this time, or before, Valerius biſhop of Hippo, againſt his will, ordained him prieſt: nevertheleſs, he continued to reſide in his little monaſtery, with his brethren, who, renouncing all property, poſſeſſed their goods in common. Valerius, who had appointed St Auguſtine to preach in his place, allowed him to do it in his preſence, contrary to the cuſtom of the churches in Africa. He explained the creed, in a general council of Africa, held in 393. Two years after, Valerius, fearing he might be preferred to be biſhop of another church, appointed him his coadjutor or colleague, and cauſed him to be ordained biſhop of Hippo, by Megalus biſhop of Calame, then primate of Numidia. St Auguſtine died the 28th day of Auguſt, 430, aged 76 years, having had the misfortune to ſee his country invaded by the Vandals, and the city where he was biſhop beſieged for ſeven months.

The works of St Auguſtine make ten volumes: the beſt edition of them is that of Maurin, printed at Antwerp, in 1700. They are but little read at this time, except by the clergy of the Greek church and in the Spaniſh univerſities. The bookſellers of London receive frequent commiſſions for them, and indeed for the moſt of the fathers, from Ruſſia, and alſo from Spain.

Augustine, *St*, a fort of North America, on the eaſt coaſt of Cape Florida, ſituated in W. Long. 81. 10. N. Lat. 30. 0. This fort was built by the Spaniards; who were ſcarce well eſtabliſhed there when they were attacked by Sir Francis Drake in 1586, who reduced and pillaged the fort and town adjacent. In 1665, it underwent a ſimilar fate, being attacked by Captain Davis at the head of a conſiderable company of bucaniers. In 1702 an attempt was made by Colonel More to annex St Auguſtine to the Britiſh dominions. He inveſted it with only 500 Engliſh and 700 Indians; which ſmall force, however, would have been ſufficient to reduce the place, had not ſuccours arrived when it was on the point of ſurrendering. Even then, it is thought that he might have defeated the reinforcement which arrived; but he choſe to raiſe the ſiege, and retire with precipitation. In 1740, another unſucceſsful attempt was made on this fort by General Oglethorpe: it was, however, together with the whole country of Florida, ceded to Great Britain by the the treaty of Paris in 1763; but has ſince been reſtored to Spain by the treaty of peace 1783.

Augustine, a cape of South America. W. Long. 35. 4. S. Lat. 8. 30.

AUGUSTINS, or Augustinians, an order of religious; thus called from St Auguſtin, whoſe rule they obſerve. The Auguſtins, popularly alſo called Auſtin friars, were originally hermits, whom Pope Alexander IV. firſt congregated into one body, under their general Lanfranc, in 1256. Soon after their inſtitution, this order was brought into England, where they had about thirty-two houſes at the time of their ſuppreſſion.

The Auguſtins are clothed in black, and make one of the four orders of mendicants. From theſe aroſe a reform, under the denomination of *bare-foot Auguſtins*, or *Minorets*, or *Friars minor*.

There are alſo canons regular of St Auguſtin, who are clothed in white, excepting their cope, which is black. At Paris they were known under the denomination of *religious of* Genevieve; that abbey was the chief of of the order. There are alſo nuns and canoneſſes, who obſerve the rules of St Auguſtin.

Augustinians are alſo thoſe divines who maintain, on the authority of St Auguſtin, that grace is effectual from its nature, abſolutely and morally, and not relatively and gradually. They are divided into rigid and relaxed.

AUGUSTOBONA, a city of the Tricaſſers in ancient Gaul, from whom it was afterwards called *Tricaſſes*, and *Trecaſſæ;* and ſtill farther corrupted to *Thracæ*, or *Treci;* whence the modern name *Troyes*, in Champagne, on the Seine. See Troyes.

AUGUSTODUNUM, the capital of the Ædui, where there was a famous academy or ſchool for the education of youth; now Auſtun, or *Autun*, in the duchy of Burgundy, on the Arroux. See Autun.

AUGUSTOMAGUS, an ancient town of Gallia Belgica; now *Sentis*, in the Iſle of France. E. Long. 2. 30. N. Lat. 49. 10.

AUGUSTORITUM, in *Ancient Geography*, accord-to ſome authors the capital of the Pictones, afterwards called *Pictavi;* now *Poictiers*. But by Antonine's Itinerary from Burdigala to Argantomagus (or Argenton, as it is interpreted by many), it can be no other but the capital of the Lemovices, now *Limoges*, ſituated between Veſunna of the Petrocorii, or Perigeux, and Argantomagus. E. Long. 1. 22. Lat. 45. 52.

AUGUSTOW, a ſmall but ſtrong town of Poland, in the duchy and palatinate of Polakia, ſeated on the river Narieu. E. Long. 24. 2. N. Lat. 53. 25.

AUGUSTUS, Fort, a ſmall fortreſs ſeated on a plain at the head of Lochneſs in Scotland, between the rivers Taarf and Oich; the laſt is a conſiderable ſtream, and has over it a ſtone bridge of three arches. The fort conſiſts of four baſtions: within is the governor's houſe, and barracks for 400 men; it was taken by the rebels in 1746, who immediately deſerted it after demoliſhing what they could. The name of this fort in Erſe is *Kill Chumin*, or *the burial place of the Cummins*. It lies on the road to the iſle of Sky, which is about 52 miles off; but on the whole way there is not a place fit for the reception of man or horſe.

Augustus, the appellation conferred upon Cæſar Octavianus, the firſt Roman emperor. See Octavianus and Rome.

The obſcure name of *Octavianus*, Mr Gibbon obſerves, he derived from a mean family, in the little town of Aricia. It was ſtained with the blood of the proſcription; and he was deſirous, had it been poſſible, to eraſe all memory of his former life. The illuſtrious ſurname of *Cæſar* he had aſſumed, as the adopted ſon of the dictator; but he had too much good ſenſe either to hope to be confounded, or to wiſh to be compared, with that extraordinary man. It was propoſed in the ſenate, to dignify their miniſter with a new appellation; and after a very ſerious diſcuſſion, that of *Auguſtus* was choſen among ſeveral others, as being the moſt expreſſive of the character of peace and ſanctity, which he uniformly affected. *Auguſtus* was therefore a perſonal, *Cæſar* a family, diſtinction. The former ſhould naturally have expired with the prince on whom it was beſtowed: and however the latter was diffuſed by adoption and female alliance, Nero was the laſt prince who could allege any hereditary claims to the honour of the Julian line. But at the time of his death, the practice of a century had inſeparably connected thoſe appellations with the imperial dignity, and they have been preſerved by a long ſucceſſion of emperors, Romans, Greeks, Franks, and Germans, from the fall of the republic to the preſent time. A diſtinction was, however, ſoon introduced. The ſacred title of *Auguſtus* was always reſerved for the monarch; the name of *Cæſar* was more freely communicated to his relations; and from the reign of Hadrian at leaſt, was appropriated to the ſecond perſon in the ſtate, who was conſidered as the preſumptive heir of the empire.

AVIARY, a place ſet apart for feeding and propagating birds. It ſhould be ſo large as to give the birds ſome freedom of flight; and turfed, to avoid the appearance of foulneſs on the floor.

AVICENNA, or Avicenes, the prince of Arabian philoſophers and phyſicians, was born at Aſſena, a village in the neighbourhood of Bokhara. His father was from Balkh in Perſia, and had married at Bokhara. The firſt years of Avicenna were devoted to the ſtudy of the Koran and the belles lettres. He ſoon ſhowed what he was likely to become afterwards; and the progreſs he made was ſo rapid, that when he was but ten years old, he was perfectly intelligent in the moſt hidden ſenſes of the Koran.

Abou-Abdoullah, a native of Napoulous in Syria, at that time profeſſed philoſophy at Bokhara with the greateſt reputation. Avicenna ſtudied under him the principles of logic; but ſoon, diſguſted with the ſlow manner of the ſchools, he ſet about ſtudying alone, and read all the authors that had written on philoſophy, without any other help than that of their commentators. Mathematics had no fewer charms for him; and after reading the firſt ſix propoſitions of Euclid, he got alone to the laſt, having made himſelf perfect maſter of them, and treaſured up all of them equally in his memory.

Poſſeſſed with an extreme avidity to be acquainted with all ſorts of ſciences, he likewiſe devoted himſelf to the ſtudy of medicine. Perſuaded that this divine art conſiſts as much in practice as in theory, he ſought all opportunities of ſeeing the ſick; and afterwards confeſſed, that he had learned more from experience than from all the old books he had read. He was now in his 16th year, and already was celebrated for being the light of his age. He reſolved at this age to reſume his ſtudies of philoſophy, which medicine had made him neglect: and he ſpent a year and a half in this painful labour, without ever ſleeping all this time a whole night together. If he felt himſelf oppreſſed by ſleep, or exhauſted by ſtudy, a glaſs of wine refreſhed his waſted ſpirits, and gave him new vigour for ſtudy; if in ſpite of him his eyes for a few minutes ſhut out the light, it then happened to him to recollect and meditate upon all the things that had occupied his thoughts before ſleep. At the age of 21, he conceived the bold deſign of incorporating, in one work, all the objects of human knowledge; and carried it into execution in an Encyclopedie of 20 volumes, to which he gave the title of the *Utility of Utilities*.

Several great princes had been taken dangerouſly ill, and Avicenna was the only one that could know their

Avicenna. ailments and cure them. His reputation increafed daily, and all the kings of Afia defired to retain him in their families.

Mahmud, the fon of Sabektekin, the firft fultan of the dynafty of the Samanides, was then the moft powerful prince of the eaft. Imagining that an implicit obedience fhould be paid by all manner of perfons to the injunctions of his will, he wrote a haughty letter to Mamun fultan of Kharazm, ordering him to fend Avicenna to him, who was at his court, with feveral other learned men. Philofophy, the friend of liberty and independence, looks down with fcorn on the fhackles of compulfion and reftraint. Avicenes, accuftomed to the moft flattering diftinctions among the great, could not endure the imperious manner of Mahmud's inviting him to his court, and refufed to go there. But the fultan of Kharazm, who dreaded his refentment, obliged the philofopher to depart with others whom that prince had demanded to be fent to him.

Avicenna pretended to obey; but inftead of repairing to Gazna, he took the route of Giorgian. Mahmud, who had gloried in the thoughts of keeping him at his palace, was greatly irritated at his flight. He defpatched portraits done in crayons of this philofopher to all the princes of Afia, with orders to have him conducted to Gazna, if he appeared in their courts. But Avicenna had fortunately efcaped the moft diligent fearch after him. He arrived in the capital of Giorgian, where under a difguifed name he performed many admirable cures.

Cabous then reigned in that country. A nephew, whom he was extremely fond of, being fallen fick, the moft able phyficians were called in, and none of them were able to know his ailment, or give him any eafe. Avicenna was at laft confulted. So foon as he had felt the young prince's pulfe, he was confident with himfelf, that his illnefs proceeded from a violent love, which he dared not to declare. Avicenna commanded the perfon who had the care of the different apartments in the palace, to name them all in their refpective order. A more lively motion in the prince's pulfe, at hearing mentioned one of thefe apartments, betrayed a part of his fecret. The keeper then had orders to name all the flaves that inhabited that apartment. At the name of one of thofe beauties, the young Cabous could not contain himfelf; an extraordinary beating of his pulfe completed the difcovery of what he in vain defired to keep concealed. Avicenes, now fully affured that this flave was the caufe of the prince's illnefs, declared, that fhe alone had the power to cure him.

The fultan's confent was neceffary, and he of courfe was curious to fee his nephew's phyfician. He had fcarce looked at him, when he knew in his features thofe of the crayoned portrait fent him by Mahmud; but Cabous, far from forcing Avicenna to repair to Gazna, retained him for fome time with him, and heaped honours and prefents on him.

This philofopher paffed afterwards into the court of Nedjmeddevle, fultan of the race of the Bouides. Being appointed firft phyfician to that prince, he found means to gain his confidence to fo great a degree, that he raifed him to the poft of grand vifir. But he did not long enjoy that illuftrious dignity. Too great an attachment to pleafures, efpecially thofe of love and the table, made him lofe at the fame time his poft and his mafter's favour. From that time Avicenna felt all the rigours of adverfity, which he had brought upon himfelf by his ill conduct. He wandered about as a fugitive, and was often obliged to fhift the place of his habitation to fecure his life from danger. He died at Hamadan, aged 58 years, in the 428th year of the Hegira, and of Chrift 1036.

The perfect knowledge he had of phyfic did not fecure him from the ailments that afflict human nature. He was attacked by feveral maladies in the courfe of his life, and particularly was very fubject to the colic. His exceffes in pleafures, and his infirmities, made a poet fay who wrote his epitaph, that the profound ftudy of philofophy had not taught him good morals, nor that of medicine the art of preferving his own health.

No one compofed with greater facility than Avicenna, writing, when he fat down to it, 50 pages generally in a day, without fatiguing himfelf. The doctors of Schiras, having made a collection of objections againft one of his metaphyfical works, fent it to him at Ifpahan by Cafem. This learned man, not arriving till towards evening, came to Avicenna's houfe, with whom he fat difcourfing till midnight. When Cafem had retired, he wrote an anfwer to the objections of the Schirazians, and finifhed it before funrife. He immediately delivered it to Cafem, telling him, that he had made all poffible defpatch in order not to detain him any longer at Ifpahan.

Avicenna, after his death, enjoyed fo great a reputation, that till the 12th century he was preferred for the ftudy of philofophy and medicine to all his predeceffors. His works were the only writings in vogue in fchools, even in Europe. The following are the titles. 1. Of the Utility and Advantage of Science, twenty books. 2. Of Innocence and Criminality, two books. 3. Of Health and Remedies, eighteen books. 4. Canons of Phyfic, fourteen books. 6. On Aftronomical Obfervations, one book. 7. On Mathematical Sciences. 8. Of Theorems, or Mathematical and Theological Demonftrations, one Book. 9. On the Arabic Language, and its Properties, ten books. 10. On the Laft Judgment. 11. On the Origin of the Soul, and the Refurrection of Bodies. 12. Of the end we fhould propofe to ourfelves in Harangues and Philofophical Argumentations. 13. Demonftration of the collateral Lines in the Sphere. 14. Abridgement of Euclid. 15. On Finity and Infinity. 16. On Phyfics and Metaphyfics. 17. On Animals and Vegetables, &c. 18. Encyclopedie, 20 volumes—Some, however, charge him with having ftolen what he publifhed from a celebrated phyfician who had been his mafter. This man had acquired fo much honour and wealth, that he was folicited by many to take their fons to be his fcholars, or even his fervants; but being refolved not to difcover the fecrets of his art, he would receive none of them. Avicenna's mother formed the following ftratagem: fhe offered him her fon as a fervant, pretending he was naturally deaf and dumb: and the youth by his mother's inftructions, counterfeited thofe defects fo well, that the phyfician, after making feveral trials to difcover the reality of them, took the boy into his fervice, and by degrees trufted him

him so far as to leave his writings open in his room when he went abroad: Avicenes took that opportunity to transcribe them, and carried the copies to his mother; and after death of his master he published them under his own name. Indeed if we reflect that he lived but 58 years, that he was a wanderer and a fugitive, and that he was much addicted to his pleasures, we shall have some difficulty to conceive how he could find time to compose so many works. Physic, however, is indebted to him for the discovery of cassia, rhubarb, mirabolans, tamarinds; and from him also, it is said, came to us the art of making sugar.

AVICENIA, Eastern Anacardium. See Botany *Index*.

AVIGATO pear. See Laurus, Botany *Index*.

AVIGLIANO, a small town of Piedmont in Italy. E. Long. 7. 5. N. Lat. 44. 40.

AVIGNON, a city of France, in the department of Vaucluse, the capital of the county of Venaissin, and seated on the banks of the Rhone. It was formerly an archbishop's see; and the residence of several popes at this place for 70 years has rendered it considerable. Near the Rhone there is a large rock, within the circumference of the walls, upon which is a platform, from whence may be had a prospect of the whole city and the places about it. This city is about three miles and two furlongs in circumference, and is in general ill built, irregular, and devoid of beauty. But it is surrounded by handsome battlemented walls and turrets, not unlike those of Rome; and its public edifices are large, solid, and grand as the taste of the fourteenth century could make them. Several popes and anti-popes, who, during their lives, shook the Romish church with violence and mutual altercation, repose quietly near each other in the various monasteries of the place. The church of the Cordeliers contains, in an obscure corner, the almost defaced tomb of Petrarch's Laura and her husband Hugh de Sade; and nearly opposite is the tomb of the brave Gullon, so well known for his invincible courage as well as for his inviolable attachment to his sovereign Henry IV. Many productions of Rene of Anjou are to be seen in the city; whose inhabitants amount to about 30,000, of whom 1000 are ecclesiastics and some hundreds Jews. The palace of the vice-legate is composed of several large square towers, and he gives audience in a great hall which is full of fine paintings, as is also the chapel and the apartments. The arsenal is near the palace.

The church of Notre Dame is ancient, but not large, and is one of the best adorned in the city. After having ascended about 50 steps, you come to a very ancient portico, which sustains a great tower; as you enter the church on the left hand, you see paintings which equal the finest in Italy. The great altar is very magnificent, and is adorned with a shrine that contains the relicks of we know not how many saints. The treasure of the sacristy is worthy of the curiosity of the traveller. The little palace where the archbishop resides is formed of three bodies of lodgings, accompanied with courts and small pavilions. It overlooks the Rhone, the city, and the fields. These buildings and the mint adorn a large square, which is the common walk of the inhabitants.

In Avignon they reckon seven gates, seven palaces, seven colleges, seven hospitals, seven monasteries, seven nunneries, and seven popes who have lived there in 70 years. The steeples are numerous, and the bells are never at rest; one of silver is rung only on the death of a pope. The church of the Celestines is very magnificent, and full of fine monuments, and the rest are not without their curiosities. The university has four colleges; and the place where the Jews live is a distinct quarter, from whence the Jews who pay tribute dare not stir out without yellow hats, and the women must have something yellow about their heads, to distinguish them from the Christians. Their number is very considerable in a very confined place, where the only way of enlarging their abodes is by building their houses higher. Their synagogue is so dark, that they are obliged to light lamps. However, they are forced to hear a monk preach a sermon every week. Across the Rhone, here, extend the ruinous and decayed arches of that bridge against which Madame de Grignan was so near being lost, and of which Madame de Sevigné makes terrified mention. It was demolished in 1699 by one of the inundations common to the Rhone. When entire, it was not less than a quarter of a mile in length; but being so narrow as not to permit two carriages to pass in any part, it had previously become almost useless; and motives of policy prevent the construction of a new bridge, while Avignon belongs to the papal see. The curious that travel this way go to see the fountain of Vaucluse, where the river Sorgues, which passes through this city, has its source; and whither Petrarch so often retired to indulge his grief and hopeless love. It is situated in a valley five miles distant from the city. The sides of the river are skirted by meadows of the most lively green; above which rise abrupt and lofty rocks, that seem designed to seclude it from human view. The valley becomes gradually narrower toward the extremity, and winding continually describes the figure of a horse-shoe. The view is at length terminated by an enormous mass of rock, forming a barrier across it, of a prodigious height, and absolutely perpendicular. Through its vast recesses run the streams which supply the fountain of Vaucluse, and at its foot appears a bason of water, several hundred feet in circumference, stretched like an expanse, silent and quiet. The sides are very steep, and it is said that in the middle no bottom can be discovered, though attempts have been often made for that purpose; a circumstance probably resulting from the violence with which the springs bubble up, which prevents any weight from descending beyond a certain depth. Though the fountain is clearer in itself than crystal, yet the incumbent rock casts a continual shade, approaching to black, over its surface. The water escaping from this state of inaction by a narrow passage, is immediately precipitated in a cascade down a rocky channel, where it foams over a number of vast detached stones, which intercept and impede its progress. They are covered with a deep green moss of many ages, and have probably tumbled from the mountain that overhangs the torrent. The rocks themselves, which surround and invest this romantic

mantic spot, are worn by time and the inclemency of the weather into a thousand extraordinary and fantastic forms, to which imagination gives shape and figure. On one of the pointed extremities, and in a situation which appears almost inaccessible, are seen the remains of an ancient castle, projecting over the water. The peasants call it *Il Castello di Petrarca;* and add, with great simplicity, that Laura lived upon the opposite side of the river, under the bed of which was a subterranean passage by which the two lovers visited each other. Nothing is however more certain, than that these are the ruins of the chateau belonging to the lords or seigneurs of Avignon; and the bishop of Cavaillon resided in it during the frequent visits which he used to make to Petrarch.—The poet's dwelling was much lower down, and nearer to the bank of the Sorgue, as evidently appears from his minute description of it, and the relation he gives of his quarrel with the Naiads of the stream, who encroached during the winter on his little adjoining territory. No remains of it are now to be discerned. Below the bridge there is an island where the Sorgues joins the Rhone, in which are several houses of pleasure. E. Long. 4. 59. N. Lat. 43. 57.

Avignon-Berry, the fruit of a species of lycium; growing plentifully near Avignon and in other parts of France. The berry is somewhat less than a pea; its colour is green, approaching towards a yellow; and it is of an astringent and bitter taste.—It is much used by the dyers, who stain a yellow colour with it: and by the painters, who also make a fine golden yellow of it.

AVILA, a city of Old Castile, in Spain, seated on an eminence on the banks of the river Adaja, and in sight of the mountains of Pico. It is fortified both by nature and art, having a wall 9075 feet in circumference, adorned with 26 lofty towers, and 10 handsome gates. There are 17 principal streets, the houses in which are generally good, and some of them stately. It hath nine squares, 2000 houses, nine parishes, as many monasteries, seven nunneries, two colleges, nine hospitals, 18 chapels, and an allowance of 10,000 ducats yearly for the maintenance of orphans and other poor people. It has an university, and a considerable bishopric; besides a noble cathedral, which has eight dignitaries, 20 canons, and the same number of minor canons. It stands in the middle of a fine large plain surrounded with mountains, and covered with fruit-trees and vineyards. There is likewise a manufacture of cloth. W. Long. 4. 13. N. Lat. 40. 35.

AVIS, a small town of Alentejo in Portugal, seated on an eminence with a castle near the river Avis. Hence the military order of the knights of Avis have their name. W. Long. 7. 0, N. Lat. 38. 40.

Avis (*Knights d'Avis*), an order of knighthood in Portugal established about the year 1162. When the city of Evora was taken from the Moors, in the reign of the first king of Portugal, it was garrisoned by several persons who assumed the title of knights of St Mary of Evora, which was soon after changed for that of knights d'Avis, which the king gave them, and whither they removed from Evora. The badge of the order is a green cross flory, and they observe the rule of St Benedict.

AVISO, a term chiefly used in matters of commerce to denote an advertisement, an advice, or piece of intelligence.

AVISON, Charles, organist of Newcastle, and a disciple of Geminiani, was the author of an essay on musical expression, published in the year 1752, in which are some judicious reflections on music in general, but his division of the modern authors into classes is rather fanciful than just. Throughout his book he celebrates Marcello and Geminiani; the latter frequently in prejudice to Mr Handel. In the year 1753 came out remarks on Mr Avison's essay on musical expression, the author whereof first points out sundry errors against the rules of composition in the works of Avison. In the same year Avison republished his essay, with a reply to the author of the remarks; and a letter, containing a number of loose particulars relating to music, collected in a course of various reading, unquestionably written by Dr Jortin. Avison promoted and assisted in the publication of Marcello's music to the psalms adapted to English words. Of his own composition there are extant five collections of concertos for violins, 44 in number; and two sets of sonatas for the harpsichord and two violins, a species of composition little known in England till his time. The music of Avison is light and elegant, but it wants originality; a necessary consequence of his too close attachment to the style of Geminiani, which in a few particulars only he was able to imitate.

AUK, in *Ornithology*. See Alca, Ornithology *Index*.

AUKLAND, Bishop's, a town in the bishopric of Durham in England, situated on the river Were. It is a sanctuary for debtors; and here the bishop has a princely palace and a noble park. W. Long. 0. 15. N. Lat. 54. 44.

AULA, is used for a court baron by Spelman; by some old ecclesiastical writers, for the nave of a church. and sometimes for a court-yard.

Aula Regia or *Regis*, a court established by William the Conqueror in his own hall, composed of the king's great officers of state, who resided in his palace, and were usually attendant on his person. This court was regulated by the article which forms the eleventh chapter of Magna Charta, and established in Westminster-hall, where it hath ever since continued. *See King's Bench.*

AULCESTER, a town of Warwickshire in England. W. Long. 1. 47. N. Lat. 52. 15.

AULETES, in antiquity, denotes a flute-player. One of the Ptolemies, kings of Egypt, father of Cleopatra, bore the surname or denomination of *Auletes*.

AULIC, an epithet given to certain officers of the empire, who compose a court which decides, without appeal, in all processes entered in it. Thus we say, *aulic council*, *aulic chamber*, *aulic counsellor*.

The aulic council is composed of a president, who is a catholic; of a vice chancellor, presented by the archbishop of Mentz; and of 18 counsellors, nine of whom are Protestants and nine Catholics. They are divided into a bench of lawyers, and always follow the emperor's court; for which reason they are called *justitium imperatoris*, the emperor's justice, and aulic council. The aulic court ceases at the death of the emperor; whereas the imperial chamber of Spire is perpetual, representing not only the deceased emperor, but

but the whole Germanic body, which is reputed never to die.

Aulic, in the Sorbonne and foreign universities, is an act which a young divine maintains upon being admitted a doctor of divinity. It begins by a harangue of the chancellor, addressed to the young doctor, after which he receives the cap, and presides at the aulic or disputation.

AULIS, in *Ancient Geography*, a town of Bœotia, over against Chalcis of Eubœa, on the Euripus, where that strait is narrowest; and which was sometimes joined with Chalcis together by a mole or causeway, (Diodorus Siculus): a craggy situation, (Homer, Nonnius); and a village of the Tanagraei, (Strabo), distant from Chalcis three miles: A harbour famous for the rendezvous of the Grecian fleet under Agamemnon, previous to the Trojan expedition, (Livy, Virgil, Pliny.) Now entirely destroyed.

AULNEGER. See Alnager.

AULON, anciently a town and dock or station for ships in Illyricum, on the Adriatic; now *Valona*, or *Volana*, a port-town in the duchy of Ferara on one of the mouths of the Po, on the gulf of Venice. E. Long. 13. N. Lat. 44. 50.

Aulon, or *Aulona*, anciently a town of Elis, in Peloponnesus on the confines of Messenia. Here stood a temple of Æsculapius; hence the epithet *Aulonius* given that divinity, (Pausanias).

AULOS, a Grecian long measure, the same with stadium.

AULPS, a town of Provence in France, in the diocese of Frejus, with the title of a vigurie. E. Long. 6. 25. N. Lat. 43. 40.

AULUS gellius. See Gellius.

AUMBRY, a country word denoting a cupboard.

AUME, a Dutch measure for Rhenish wine, containing 40 English gallons.

AUNCEL-weight, an ancient kind of balance now out of use, being prohibited by several statutes, on account of the many deceits practised by it. It consisted of scales hanging on hooks, fastened at each end of a beam, which a man lifted up on his hand. In many parts of England, auncel-weight signifies meat sold by the hand, without scales.

AUNE, a long measure used in France to measure cloths, stuffs, ribbons, &c. At Rouen, it is equal to one English ell; at Calais, to 1.52; at Lyons, to 1.061; and at Paris, to 0.95.

AUNGERVYLE, Richard, commonly known by the name of *Richard de Bury*, was born in 1281 at St Edmund's Bury in Suffolk, and educated at the university of Oxford: After which he entered into the order of Benedictine monks, and became tutor to Edward prince of Wales, afterwards King Edward III. Upon the accession of his royal pupil to the throne he was first appointed cofferer, then treasurer of the wardrobe, archdeacon of Northampton, prebendary of Lincoln, Sarum, and Litchfield, keeper of the privy seal, dean of Wells, and last of all was promoted to the bishopric of Durham. He likewise enjoyed the offices of lord high chancellor, and treasurer of England; and discharged two important embassies at the court of France. Learned himself, and a patron of the learned, he maintained a correspondence with some of the greatest geniuses of the age, particularly with the celebrated Italian poet Petrarch. He was also of a most humane and benevolent temper, and performed many signal acts of charity. Every week he made eight quarters of wheat into bread, and gave it to the poor. Whenever he travelled between Durham and Newcastle, he distributed eight pounds sterling in alms: between Durham and Stockton five pounds, between Durham and Aukland five marks, and between Durham and Middleham five pounds. He founded a public library at Oxford, for the use of the students, which he furnished with the best collection of books then in England; and appointed five keepers, to whom he granted yearly salaries. At the dissolution of religious houses in the reign of Henry VIII. Durham college, where he fixed the library, being dissolved among the rest, some of the books were removed to the public library, some to Baliol college, and some came into the hands of Dr George Owen, a physician of Godstow, who bought that college of King Edward VI. Bishop Aungervyle died at his manor of Aukland, April 24. 1345, and was buried in the south part of the cross aisle of the cathedral church of Durham, to which he had been a benefactor. He wrote, 1. *Philobiblos*, containing directions for the management of his library at Oxford, and a great deal in praise of learning, in bad Latin. 2. *Epistolæ familiarium;* some of which are written to the famous Petrarch. 3. *Orationes ad principes;* mentioned by Bale and Pitts.

AUNIS, the smallest province in France, bounded on the north by Poictou, on the west by the ocean, on the east and south by Saintogne, of which it was formerly a part. It is watered by the rivers Seure and Sarente, the former of which has its source at Seure in Poictou. The coast of this small district has the advantage of several ports, the most remarkable of which are Rochefort, Rochelle, Brouge, St Martin de Re, Tremblade, Tonnai, and Charente. The soil of this country is dry, yet produces good corn and plenty of wine. The marshes feed a great number of cattle, and the salt marshes yield the best salt in Europe.

AVOCADO, or Avigato, *Pear*. See Laurus, Botany *Index*.

AVOCATORIA, a mandate of the emperor of Germany, addressed to some prince, in order to stop his unlawful proceedings in any cause appealed to him.

AVOIDANCE, in the *Canon Law*, is when a benefice becomes void of an incumbent; which happens either in fact, as by the death of the person; or in law, as by cession, deprivation, resignation, &c. In the first of these cases, the patron must take notice of the avoidance at his peril; but in avoidance by law, the ordinary is obliged to give notice to the patron, in order to prevent a lapse.

AVOIRDUPOIS. This is the weight for the larger and coarser commodities, such as groceries, cheese, wool, lead, &c. Bakers, who live not in corporation towns, are to make their bread by avoirdupois weight, those in corporations by troy weight. Apothecaries buy by avoirdupois weight, but sell by troy. The proportion of a pound avoirdupois to a pound troy is as 17 to 14.

AVOSETTA. See Recurvirostra, Ornithology *Index*.

AVOWEE, one who has a right to present to a benefice. He is thus called in contradistinction to those

those who only have the lands to which the advowson belongs for a term of years, or by virtue of intrusion or disseisin.

AVOWRY, in *Law*, is where a person distrained sues out a replevin; for then the distrainer must vow, and justify his plea, which is called his *avowry*.

AURA, among *Physiologists*, an airy exhalation or vapour. The word is Latin, derived from the Greek, αυρα, *gentle wind*.

AURACH, a town of Germany with a good castle, in the south part of Suabia, in the duchy of Wirtemberg. It is the usual residence of the youngest sons of the house of Wirtemberg, and is seated at the foot of a mountain on the rivulet Ermst. E. Long. 9. 20. N. Lat. 48. 25.

AURÆ, in *Mythology*, a name given by the Romans to the nymphs of the air. They are mostly to be found in the ancient paintings of ceilings; where they are represented as light and airy, generally with long robes and flying veils of some lively colour or other, and fluttering about in the rare and pleasing element assigned to them. They are characterized as sportive and happy in themselves, and wellwishers to mankind.

AURANCHES, the capital of a territory called *Auranchin*, about 30 miles in length, in Lower Normandy in France, now the department of the Channel. The city is mean; but its situation very fine, being on an eminence, near which the river See runs, about a mile and a half from the ocean. The cathedral stands on a hill, which terminates abruptly; the front of the church extending to the extreme verge of it, and overhanging the precipice. It bears the marks of high antiquity; but the towers are decayed in many places, though its original construction has been wonderfully strong. Here, you are told, the English Henry II. received absolution from the Papal nuncio for the murder of St Thomas-a-Becket in 1172, and the stone on which he knelt during the performance of that ceremony is shown to strangers. Its length is about 30 inches, and the breadth 12. It stands before the north portal, and on it is engraved a chalice in commemoration of the event. The ruins of the castle of Auranches are very extensive; and beneath lies a rich extent of country, abounding in grain and covered with orchards, from the fruit of which is made the best cyder in Normandy. W. Long. 1. 20. N. Lat. 48. 51.

AURANTIUM, in *Botany*. See CITRUS, BOTANY *Index*.

AURAY, a small seaport town of Lower Britanny in France, situated in the gulf called *Morbihan*, and in the department of the same name. It consists of only one handsome street, and is chiefly known for its trade. W. Long. 2. 25. N. Lat. 47. 48.

AURELIA, in *Natural History*, the same with what is more usually called *chrysalis*, and sometimes *nymph*. See CHRYSALIS; ENTOMOLOGY *Index*.

AURELIANUS, LUCIUS DOMITIUS, emperor of Rome, was one of the greatest generals of antiquity, and commanded the armies of the emperor Claudius with such glory, that after the death of that emperor all the legions agreed to place him on the throne: this happened in the year 270. He carried the war from the east to the west, with as much facility, says a modern writer, as a body of troops marches from Alsace into Flanders. He defeated the Goths, Sarmatians, Marcomanni, the Persians, Egyptians, and Vandals; conquered Zenobia queen of the Palmyrenians, and Tetricus general of the Gauls; both of whom were made to grace his triumph, in the year 274. He was killed by one of his generals in Thrace in the year 275, when he was preparing to enter Persia with a great army. See ROME.

AURELIUS VICTOR. See VICTOR.

AURENGABAD, a city in the East Indies, capital of the province of Balagate, in the dominions of the Great Mogul. It is furnished with handsome mosques and caravanseras. The buildings are chiefly of freestone, and pretty high, and the streets planted on each side with trees. They have large gardens well stocked with fruit trees and vines. The soil about it is also very fertile, and the sheep fed in its neighbourhood are remarkably large and strong. E. Long. 75. 30. N. Lat. 19. 10.

AURENG-ZEBE, a celebrated Mogul emperor. See INDOSTAN.

AUREOLA, in its original signification, signifies a jewel, which is proposed as a reward of victory in some public dispute. Hence the Roman schoolmen applied it to denote the reward bestowed on martyrs, virgins, and doctors, on account of their works of supererogation; and painters use it to signify the crown of glory with which they adorn the heads of saints, confessors, &c.

AUREUS, a Roman gold coin, equal in value to 25 denarii. According to Ainsworth, the aureus of the higher empire weighed near five pennyweights; and in the lower empire, little more than half that weight. We learn from Suetonius, that it was customary to give aurei to the victors in the chariot races.

AUREUS MONS, in *Ancient Geography*, a mountain in the north west of Corsica, whose ridge runs out to the north-east and south-east, forming an elbow.—Another mountain of Moesia Superior, or Servia (Peutinger), to the south of the Danube, with a cognominal town at its foot on the same river. The emperor Probus planted this mountain with vines (Eutropius).

AURICK, a city of Germany; in East Friesland, in the circle of Westphalia; to which the king of Prussia claims a right. It is situated in a plain surrounded with forests full of game. E. Long. 6. 50. N. Lat. 53. 28.

AURICLE, in *Anatomy*, that part of the ear which is prominent from the head, called by many authors *auris externa*.

AURICLES are likewise two muscular bags situated at the basis of the heart, and intended as diverticula for the blood during the diastole.

AURICULA, in *Botany*. See PRIMULA, BOTANY *Index*.

AURIFLAMMA, in the *French History*, properly denotes a flag or standard belonging to the abbey of St Dennis, suspended over the tomb of that saint, which the religious on occasion of any war in defence of their lands or rights, took down with great ceremony, and gave it to their protector or advocate, to be borne at the head of their forces.

AURIFLAMMA is also sometimes used to denote the chief flag or standard in any army.

AURIGA, *the* WAGGONER, in *Astronomy*, a constellation

Auriliac || Aurora Borealis.

ſtellation of the northern hemiſphere, conſiſting of 23 ſtars, according to Tycho; 40, according to Hevelius; and 68, in the Britannic catalogue.

AURILLAC, a town of France in the Lower Auvergne, now the department of Cantal, ſeated on a ſmall river called *Jourdane*. It is one of the moſt conſiderable towns of the province, has ſix gates, is very populous, and yet has but one pariſh. The caſtle is very high, and commands the town. The abbot was lord of Aurillac, and had epiſcopal juriſdiction; and was alſo chief juſtice of the town. This place is remarkable for having produced ſeveral great men. E. Long. 2. 33. N. Lat. 44. 55.

AURIPIGMENTUM, ORPIMENT, in *Natural Hiſtory*. See ORPIMENT.

AURISCALPIUM, an inſtrument to clean the ears, and ſerving alſo for other operations in diſorders of that part.

AURORA, the morning twilight, or that faint light which appears in the morning when the ſun is within 18 degrees of the horizon.

AURORA, the goddeſs of the morning, according to the Pagan mythology. She was the daughter of Hyperion and Theia, according to Heſiod; but of Titan and Terra, according to others. It was under this name that the ancients deified the light which foreruns the riſing of the ſun above our hemiſphere. The poets repreſent her as riſing out of the ocean, in a chariot, with roſy fingers dropping gentle dew. Virgil deſcribes her aſcending in a flame-coloured chariot with four horſes.

AURORA, one of the New Hebrides iſlands in the South ſea, in which Mr Forſter ſuppoſes the *Peak d'Etoile* mentioned by Mr Bouganville to be ſituated. The iſland is inhabited; but none of its inhabitants came off to viſit Captain Cook. The country is woody, and the vegetation ſeemed to be exceſſively luxuriant. It is about 12 leagues long, but not above five miles broad in any part; lying nearly north and ſouth. The middle lies in S. Lat. 15. 6. E. Long. 168. 24.

AURORA BOREALIS, *Northern Twilight*, or *Streamers*; a kind of meteor appearing in the northern part of the heavens, moſtly in the winter-time, and in froſty weather. It is now ſo generally known, that no deſcription is requiſite of the appearance which it uſually makes in this country. But it is in the arctic regions that it appears in perfection, particularly during the ſolſtice. In the Schetland iſlands, the *merry dancers*, as they are there called, are the conſtant attendants of clear evenings, and prove great reliefs amidſt the gloom of the long winter nights. They commonly appear at twilight near the horizon, of a dun colour, approaching to yellow; ſometimes continuing in that ſtate for ſeveral hours without any ſenſible motion; after which they break out into ſtreams of ſtronger light, ſpreading into columns, and altering ſlowly into ten thouſand different ſhapes, varying their colours from all the tints of yellow to the obſcureſt ruſſet. They often cover the whole hemiſphere, and then make the moſt brilliant appearance. Their motions at theſe times are moſt amazingly quick; and they aſtoniſh the ſpectator with the rapid change of their form. They break out in places where none were ſeen before ſkimming briſkly along the heavens; are ſuddenly extinguiſhed, and leave behind an uniform duſky tract. This again is brilliantly illuminated in the ſame manner, and as ſuddenly left a dull blank. In certain nights they aſſume the appearance of vaſt columns, on one ſide of the deepeſt yellow, on the other declining away till it becomes undiſtinguiſhed from the ſky. They have generally a ſtrong tremulous motion from end to end, which continues till the whole vaniſhes. In a word, we, who only ſee the extremities of theſe northern phenomena, have but a faint idea of their ſplendour and their motions. According to the ſtate of the atmoſphere, they differ in colours. They often put on the colour of blood, and make a moſt dreadful appearance. The ruſtic ſages become prophetic, and terrify the gazing ſpectators with the dread of war, peſtilence, and famine. This ſuperſtition was not peculiar to the northern iſlands; nor are theſe appearances of recent date. The ancients called them *Chaſmata*, and *Trabes*, and *Bolides*, according to their forms or colours.

1 This meteor formerly very rare.

In old times they were extremely rare, and on that account were the more taken notice of. From the days of Plutarch to thoſe of our ſage hiſtorian Sir Richard Baker, they were ſuppoſed to have been portentous of great events, and timid imagination ſhaped them into aerial conflicts:

> Fierce fiery warriors fight upon the clouds
> In ranks and ſquadrons and right form of war.

Dr Halley tells us, that when he ſaw a great aurora borealis in 1716, he had begun to deſpair of ever ſeeing one at all; none having appeared, at leaſt in any conſiderable degree, from the time he was born till then. Notwithſtanding this long interval, however, it ſeems that in ſome periods the aurora borealis had been ſeen much more frequently; and perhaps this, as well as other natural phenomena, may have ſome ſtated times of returning.

2 Hiſtory by Dr Halley.

The only thing that reſembles a diſtinct hiſtory of this phenomenon, is what we have from the learned Dr Halley, Phil. Tranſ. N° 347. The firſt account he gives, is of the appearance of what is called by the author *burning ſpears*, and was ſeen at London on January 30th, 1560. This account is taken from a book entitled, *A Deſcription of Meteors*, by *W. F.* D. D. and reprinted at London in 1654. The next appearance, on the teſtimony of Stow, was on October 7th, 1564. In 1574 alſo, according to Camden, and Stow abovementioned, an aurora borealis was obſerved two nights ſucceſſively, viz. on the 14th and 15th of November, with much the ſame appearances as deſcribed by Dr Halley in 1716, and which we now ſo frequently obſerve. Again, the ſame was twice ſeen in Brabant, in the year 1575; viz. on the 13th of February and 28th of September. Its appearances at both theſe times were deſcribed by Cornelius Gemma, profeſſor of medicine in the univerſity of Louvain, who compares them to ſpears, fortified cities, and armies fighting in the air. After this, Michael Mæſtlin, tutor to the great Kepler, aſſures us, that at Baknang in the county of Wurtemberg in Germany, theſe phenomena, which he ſtyles *chaſmata*, were ſeen by himſelf no leſs than ſeven times in 1580. In 1581, they again appeared in an extraordinary manner in April and September, and in a leſs degree at ſome other times of the ſame year. In 1621, September 2d, this phenomenon was obſerved all over France,

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France, and defcribed by Gaffendus, who gave it the name of *aurora borealis*: yet neither this, nor any fimilar appearances pofterior to 1574, are defcribed by Englifh writers till the year 1707; which, as Dr Halley obferves, fhows the prodigious neglect of curious matters which at that time prevailed. From 1621 to 1707, indeed, there is no mention made of an aurora borealis being feen by any body; and confidering the number of aftronomers who during that period were in a manner continually poring on the heavens, we may very reafonably conclude that no fuch thing did make its appearance till after an interval of 86 years. In 1707, a fmall one was feen in November; and during that year and the next, the fame appearances were repeated five times. The next on record is that mentioned by Dr Halley in March 1715—16, the brilliancy of which attracted univerfal attention, and by the vulgar was confidered as marking the introduction of a foreign race of princes. Since that time thofe meteors have been fo common, that no accounts have been kept of them.

3 Mr Forfter's account of fimilar appearances in the fouthern hemifphere.

It was for a long time a matter of doubt whether this meteor made its appearance only in the northern hemifphere, or whether it was alfo to be obferved near the fouth pole. This is now afcertained by Mr Forfter; who in his late voyage round the world along with Captain Cook, affures us, that he obferved them in the high fouthern latitudes, though with phenomena fomewhat different from thofe which are feen here. On Feb. 17. 1773, as they were in Lat. 58° fouth, "A beautiful phenomenon (fays he) was obferved during the preceding night, which appeared again this and feveral following nights. It confifted of long columns of a clear white light, fhooting up from the horizon to the eaftward, almoft to the zenith, and gradually fpreading on the whole fouthern part of the fky. Thefe columns were fometimes bent fidewife at their upper extremities; and though in moft refpects fimilar to the northern lights (*aurora borealis*) of our hemifphere, yet differed from them in being always of a whitifh colour, whereas ours affume various tints, efpecially thofe of a fiery and purple hue. The fky was generally clear when they appeared, and the air fharp and cold, the thermometer ftanding at the freezing-point."

4 Rifes very high.

Dr Halley obferved that the aurora borealis defcribed by him arofe to a prodigious height, it being feen from the weft of Ireland to the confines of Ruffia and Poland on the eaft; nor did he know how much further it might have been vifible; fo that it extended at leaft 30 degrees in longitude, and from Lat. 50° north it was feen over all the northern part of Europe; and what was very furprifing, in all thofe places where it was vifible, the fame appearances were exhibited which Dr Halley obferved at London. He obferves, with feeming regret, that he could by no means determine its height, for want of obfervations made at different places; otherwife he might as eafily have calculated the height of this aurora borealis, as he did of the fiery globe in 1719 *. To other philofophers, however, he gives the following exhortation. "When therefore for the future any fuch thing fhall happen, all thofe that are curious in aftronomical matters are hereby *admonifhed* and *entreated* to fet their clocks to the apparent time at London, for example, by allowing fo many minutes as is the difference of meridians; and then to note, at the end of every half hour precifely, the exact fituation of what at that time appears remarkable in the fky; and particularly the azimuths of thofe very tall pyramids fo eminent above the reft, and therefore likely to be feen furtheft: to the intent that, by comparing thefe obfervations taken at the fame moment in diftant places, the difference of their azimuths may ferve to determine how far thefe pyramids are diftant from us." This advice of Dr Halley feems to have been totally neglected by all the philofophical people in his country. In other countries, however, they have been more induftrious. Father Bofcovich has determined the height of an aurora borealis, obferved on the 16th of December 1737 by the marquis of Poleni, to have been 825 miles high; the celebrated Mr Bergman, from a mean of 30 computations, makes the average height of the aurora borealis to be 70 Swedifh, or upwards of 460 Englifh miles. Euler fuppofes it to be feveral thoufands of miles high; and Mairan alfo affigns them a very elevated region. In the 74th volume of the Philofophical Tranfactions, Dr Blagden, when fpeaking of the height of fome fiery meteors, tells us, that the "aurora borealis appears to occupy as high, if not a higher region above the furface of the earth, as may be judged from the very diftant countries to which it has been vifible at the fame time." The height of thefe meteors, however, none of which appear to have exceeded or even arrived at the height of a hundred miles, muft appear trifling in comparifon of the vaft elevations above mentioned. But thefe enormous heights, varying fo exceedingly, fhow that the calculators have not had proper data to proceed upon; and indeed the immenfe extent of fpace occupied by the aurora borealis itfelf, with its conftant motion, muft make it infinitely more difficult to determine the height of it than of a fiery globe, which occupies but a fmall portion of the vifible heavens. The moft certain method of making a comparifon betwixt the aurora borealis and the meteors already mentioned, would be, if a ball of fire fhould happen to pafs through the fame part of the heavens where an aurora borealis was; when the comparative height of both could eafily be afcertained. One inftance of this only has come under our obfervation, where one of the fmall meteors, called *falling ftars*, was evidently obfcured by an aurora borealis; and therefore muft have been higher than the lower part of the latter at leaft. A fingularity in this meteor was, that it did not proceed in a ftraight line through the heavens, as is ufual with falling ftars, but defcribed a very confiderable arch of a circle, rifing in the north-weft, and proceeding fouthward a confiderable way in the arch of a circle, and difappearing in the north. Its edges were ill defined, and five or fix corrufcations feemed to iffue from it like the rays painted as iffuing from ftars. The aurora borealis was not in motion, but had degenerated into a crepufculum in the northern part of the hemifphere. Indeed, in fome cafes this kind of crepufculum appears fo plainly to be connected with the clouds, that we can fcarcely avoid fuppofing it to proceed from them. We cannot, however, argue from this to the height of the aurora borealis when it moves with great velocity, becaufe it then may, and very probably does, afcend much higher. Dr Blagden, indeed,

* See *Atmofphere*.

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deed, informs us, that instances are recorded, where the northern lights have been seen to join, and form luminous balls, darting about with great velocity, and even leaving a train like the common fire-balls. It would seem, therefore, that the highest regions of the aurora borealis are the same with those in which fire balls move.

5
Conjectures concerning the cause of this meteor.

With regard to the cause of the aurora borealis many conjectures have been formed. The first which naturally occurred was, that it was occasioned by the ascent of inflammable sulphureous vapours from the earth. To this supposition Dr Halley objects the immense extent of such phenomena, and that they are constantly observed to proceed from north to south, but never from south to north. This made him very reasonably conclude, that there was some connexion between the poles of the earth and the aurora borealis; but being unacquainted with the electric power, he supposed, that this earth was hollow, having within it a magnetical sphere, which corresponded in virtue with all the natural and artificial magnets on the surface; and the magnetic effluvia passing through the earth, from one pole of the central magnet to another, might sometimes become visible, in their course, which he thought was from north to south, and thus exhibit the beautiful coruscations of the aurora borealis. Had Dr Halley, however, known that a stroke of electricity would give polarity to a needle that had it not, or reverse the poles of one that had it before, he would undoubtedly have concluded the electric and magnetic effluvia to be the same, and that the aurora borealis was this fluid performing its circulation from one pole of the earth to the other. In fact, this very hypothesis is adapted by S. Beccaria: and by the supposed circulation of the electric fluid he accounts for the phenomena of magnetism and the aurora borealis in a manner perfectly similar to that of Dr Halley, only changing the phrase *magnetic effluvia* for *electric fluid*. The following is the account given us by Dr Priestley of Beccaria's sentiments on this matter.

"Since a sudden stroke of lightning gives polarity to magnets, he conjectures, that a regular and constant circulation of the whole mass of the fluid from north to south may be the original cause of magnetism in general.

"That this ethereal current is insensible to us, is no proof of its non-existence, since we ourselves are involved in it. He had seen birds fly so near a thunder-cloud, as he was sure they would not have done had they been affected by its atmosphere.

"This current he would not suppose to arise from one source, but from several, in the northern hemisphere, of the earth; and he thinks that the aurora borealis may be this electric matter performing its circulation in such a state of the atmosphere as renders it visible, or approaching the earth nearer than usual. Accordingly, very vivid appearances of this kind have been observed to occasion a fluctuation in the magnetic needle."

A direct disproof of this circulation, however, is furnished by the observation of Mr Forster already mentioned: with which, though neither Dr Halley nor S. Beccaria could be acquainted, they might have thought of it as a final proof either of the truth or falsehood of their hypothesis.—If the aurora borealis is no other than the electric fluid performing the above-mentioned circulation, it ought to dart from the horizon towards the zenith in the northern hemisphere, and from the zenith to the horizon in the southern one: but Mr Forster plainly tells us, that the columns shot up from the horizon towards the zenith as well in the southern hemisphere as in the northern; so that if the aurora borealis is to be reckoned the flashings of electric matter, its course is plainly directed from both poles toward the equator, and not from one pole to the other.

Concerning the cause of this phenomenon, Mr Canton has the following query: "Is not the aurora borealis the flashing of electrical fire from positive towards negative clouds at a great distance, through the upper part of the atmosphere where the resistance is least?" But to this we must reply in the negative; for in this case it would flash in every direction according to the position of the clouds, as well as from north to south. Besides this query, he conjectures, that when the needle is disturbed by the aurora borealis, that phenomenon proceeds from the electricity of the heated air; and supposes the air to have the property of becoming electric by heat, like the tourmalin. But neither does this hypothesis appear at all probable; because, in such a case, the aurora borealis ought to be most frequent in summer when the air is most heated, whereas it is found to be the reverse. Lastly, with these electrical hypotheses we shall contrast that of Mr Mairan, who imagined this phenomenon to proceed from the atmosphere of the sun, particles of which were thrown off by its centrifugal force acquired by his rotation on his axis; and that these particles falling upon the atmosphere of the earth near its equatorial parts, were from thence propelled by the diurnal motion of the earth towards the polar regions, where they formed the aurora borealis. This hypothesis, besides its being a mere supposition unsupported by one single appearance in nature, is liable to the objection already mentioned; for in this case the light should dart from the equator to the poles, and not from the poles to the equator: or if we should suppose this matter to be gradually accumulated at each of the poles, we must then make other suppositions equally vague and ill founded, concerning its getting back with such surprising rapidity in direct opposition to the power which once brought it thither.

The first person who seems to have endeavoured to find any positive proof of the electrical quality of the aurora borealis, was Dr Hamilton of Dublin. He observes, that though this phenomenon is commonly supposed to be electrical, yet he had not seen any attempt to prove that it is so; but the only proof he himself brings is an experiment of Mr Hawksbee, by which the electric fluid is shown to put on appearances somewhat like the aurora borealis, when it passes through a vacuum. He observed, that when the air was most perfectly exhausted, the streams of electric matter were then quite white; but when a small quantity of air was let in, the light assumed more of a purple colour. The flashing of this light therefore from the dense regions of the atmosphere into such as are more rare, and the transitions through mediums of different density, he reckons the cause of the aurora borealis, and of the different colours it assumes.

Dr Hamilton's proof, then, of the electricity of the

the aurora borealis, consists entirely in the resemblance the two lights bear to one another; and if to this we add, that, during the time of an aurora borealis, the magnetic needle hath been disturbed, electric fire obtained from the atmosphere in plenty, and at some times different kinds of rumbling and hissing sounds heard, we have the sum of all the positive evidence in favour of the electric hypothesis.

Was the aurora borealis the first natural phenomenon the solution of which had been attempted by electricity, no doubt the proofs just now adduced would be very insufficient: but when it is considered, that we have indisputable evidence of the identity of the phenomena of thunder and of electricity; when we also consider, that the higher parts of our atmosphere are continually in a strongly electrified state; the analogy becomes so strong that we can scarce doubt of the aurora borealis arising from the same cause. The only difficulty is, to give a good reason why the electricity of the atmosphere should be constantly found to direct its course from the poles towards the equator, and not from the equator to the poles; and this we think may be done in the following manner.

See *Electricity* passim.

1. It is found that all electric bodies, when considerably heated, become conductors of electricity; thus hot air, hot glass, melted rosin, sealing-wax, &c. are all conductors, till their heat is dissipated, and then they again become electrics.

2. As the converse of every true proposition ought also to be true, it follows from the above one, that if electrics when heated become conductors, then non-electrics when subjected to violent degrees of cold ought to become electric. In one instance this has been verified by experience; water, which is a conductor when warm or not violently cooled, is found to become electric when cooled to 20° below 0 of Fahrenheit's thermometer. With regard to metallic substances, indeed, no experiments have as yet been made to determine whether their conducting power is affected by cold or not. Very probably we might not be able to produce such a degree of cold as sensibly to lessen their conducting power; but still the analogy will hold; and, as we are by no means able to produce the greatest degree of cold possible, reason will always suggest to us, that if a certain degree of cold changes one conductor into an electric, a sufficient degree of it will also change all others into electrics.

3. If cold is sufficient to change conducting substances into electrics, it must also increase the electric power of such substances as are already electric; that is to say, very cold air, glass, rosin, &c. provided they are dry, will be more electric than when they are warmer. With regard to air, which is most to our present purpose, this is rendered extremely probable, by considering that clear frosty weather is of all others the most favourable for electric experiments. They may be made indeed to equal advantage almost in any state of the atmosphere, provided sufficient pains are used, but in dry hard frosts they will succeed much more easily than at any other time.

These three axioms being allowed, the cause of the aurora borealis is easily deduced from them. The air, all round the globe, at a certain height above its surface, is found to be exceedingly cold, and, as far as experiments have yet determined, exceedingly electrical also. The inferior parts of the atmosphere between the tropics, are violently heated during the day-time by the reflection of the sun's rays from the earth. Such air will therefore be a kind of conductor, and much more readily part with its electricity to the clouds and vapours floating in it, than the colder air towards the north and south poles. Hence the prodigious appearances of electricity in these regions, showing itself in thunder and other tempests of the most terrible kind. Immense quantities of the electric fluid are thus communicated to the earth; and the inferior warm atmosphere having once exhausted itself, must necessarily be recruited from the upper and colder region. This becomes very probable from what the French mathematicians observed when on the top of one of the Andes. They were often involved in clouds, which, sinking down into the warmer air, appeared there to be highly electrified, and discharged themselves in violent tempests of thunder and lightning; while in the mean time, on the top of the mountain, they enjoyed a calm and serene sky. In the temperate and frigid zones, the inferior parts of the atmosphere never being so strongly heated, do not part with their electricity so easily as in the torrid zone, and consequently do not require such recruits from the upper regions: but notwithstanding the difference of heat observed in different parts of the earth near the surface, it is very probable that at considerable heights the degrees of cold are nearly equal all round it. Were there a like equality in the heat of the under part, there could never be any considerable loss of equilibrium in the electricity of the atmosphere: but as the hot air of the torrid zone is perpetually bringing down vast quantities of electric matter from the cold air that lies directly above it; and as the inferior parts of the atmosphere lying towards the north and south poles do not conduct in any great degree; it thence follows, that the upper parts of the atmosphere lying over the torrid zone will continually require a supply from the northern and southern regions. This easily shows the necessity of an electric current in the upper parts of the atmosphere from each pole towards the equator: and thus we are also furnished with a reason why the aurora borealis appears more frequently in winter than in summer; namely, because at that time the electric power of the inferior atmosphere is greater on account of the cold than in summer; and consequently the abundant electricity of the upper regions must go almost wholly off to the equatorial parts, it being impossible for it to get down to the earth: hence also the aurora borealis appears very frequent and bright in the frigid zones, the degree of cold in the upper and under regions of the atmosphere being much more nearly equal in these parts than in any other. In some parts of Siberia particularly, this meteor appears constantly from October to Christmas, and its coruscations are said to be very terrifying. Travellers agree, that here the aurora borealis appears in greatest perfection; and it is to be remarked, that Siberia is the coldest country on earth. In confirmation of this, it may also be observed, that, from the experiments hitherto made with the electrical kite, the air appears considerably more electrical in winter than in summer, though the clouds are known to be often most violently electrified in the summer time; a proof, that the electricity na-

turally

Aurora Borealis.

turally belonging to the air is in ſummer much more powerfully drawn off by the clouds than in the winter, owing to the exceſs of heat in ſummer, as already obſerved.

A conſiderable difficulty, however, ſtill remains from the upright poſition which the ſtreams of the aurora borealis are generally ſuppoſed to have; whereas, according to the hypotheſis above mentioned, they ought rather to run directly from north to ſouth. This difficulty occurred to Dr Halley: but he anſwers it by ſuppoſing his magnetic effluvia to paſs from one pole to another in arches of great circles, ariſing to a vaſt height above the earth, and conſequently darting from the places whence they aroſe almoſt like the radii of a circle; in which caſe, being ſent off in a direction nearly perpendicular to the ſurface of the earth, they muſt neceſſarily appear erect to thoſe who ſee them from any part of the ſurface, as is demonſtrated by mathematicians. It is alſo reaſonable to think that they will take this direction rather than any other, on account of their meeting with leſs reſiſtance in the very high regions of the air than in ſuch as are lower.

But the greateſt difficulty ſtill remains: for we have ſuppoſed the equilibrium of the atmoſphere to be broken in the daytime, and reſtored only in the night; whereas, conſidering the immenſe velocity with which the electric fluid moves, the equilibrium ought to be reſtored in all parts almoſt inſtantaneouſly; yet the aurora borealis never appears except in the night, although its brightneſs is ſuch as muſt ſometimes make it viſible to us did it really exiſt in the daytime.

In anſwer to this it muſt be obſerved, that though the paſſage of electricity through a good conductor is inſtantaneous, yet through a bad conductor it is obſerved to take ſome time in paſſing. As our atmoſphere therefore, unleſs very violently heated, is but a bad conductor of electricity; though the equilibrium in it is broken, it can by no means be inſtantaneouſly reſtored. Add to this, that as it is the action of the ſun which breaks the equilibrium, ſo the ſame action, extending over half the globe, prevents almoſt any attempt to reſtore it till night, when flaſhes ariſe from various parts of the atmoſphere, gradually extending themſelves with a variety of undulations towards the equator.

It now remains to explain only one particularity of the aurora borealis, namely, that its ſtreams do not always move with rapidity; ſometimes appearing quite ſtationary for a conſiderable time, and ſometimes being carried in different directions with a ſlow motion. To this indeed we can give no other reply, than that weak electric lights have been ſometimes obſerved to put on the ſame appearance at the ſurface of the earth: and much more may we ſuppoſe them capable of doing ſo at great heights above it, where the conductors are both fewer in number and much more imperfect. When M. de Romas was making experiments with an electric kite in Italy, a cylinder of blue light about four or five inches diameter was obſerved ſurrounding the ſtring. This was in the daytime; but had it been night, he imagined it muſt have been four or five feet in diameter; and as the ſtring was 780 feet long, it would probably have ſeemed pyramidal, pointing upwards like one of the ſtreams of the aurora borealis. A ſtill more remarkable appearance, Dr Prieſtley tells us, was obſerved by Mr Hartman. He had been making electrical experiments for four or five hours together in a very ſmall room; and upon going out of it, and returning with a light in his hand, walking pretty quick, he perceived a ſmall flame following him at about three feet diſtance. Being alarmed at this appearance, he ſtopped to examine it, upon which it vaniſhed. This laſt inſtance is very remarkable, and ſingular in its kind: from both, however, we are ſufficiently warranted to conclude, that ſmall portions of our atmoſphere may by various cauſes be ſo much electrified as to ſhine, and likewiſe be moved from one place to another without parting with the electricity they have received, for a conſiderable time.

The corona, or circle, which is often formed near the zenith by the aurora borealis, is eaſily accounted for in the ſame manner. As this corona is commonly ſtationary for ſome time, we imagine it would be a very proper mark whereby to determine the diſtance of the meteor itſelf. If an aurora borealis, for inſtance, was obſerved by two perſons, one at London, and the other at Edinburgh; by noting the ſtars among which the corona was obſerved at each place, its true altitude from the ſurface of the earth could eaſily be determined by trigonometry.

Under the article Atmosphere it was ſuggeſted, that no good proof had been as yet brought for the extreme rarity of the air uſually ſuppoſed to take place at no very great heights above the earth. The brightneſs of the meteor there mentioned at 70 miles perpendicular from the ſurface, as alſo its figure, ſeemed to prove the air conſiderably denſer at that diſtance from the earth. Though the height of the aurora borealis has never been determined, we can ſcarce imagine it to be greater than that of this meteor, or indeed ſo great: but although its ſtreams reſemble the paſſage of electric light through a vacuum, it cannot be from thence inferred, that the air is at all in a ſtate ſimilar to the vacuum of an air-pump in thoſe places where the aurora borealis is produced; ſeeing we have inſtances of ſimilar appearances being produced in very denſe air. The plate of an electrophorus is often ſo highly electrified, as to throw out flaſhes from different parts as ſoon as it is lifted up, and by proper management it may be always made to emit long and broad flaſhes which ſhall ſcarcely be felt by the finger, inſtead of ſmall, denſe, and pungent ſparks; ſo that, though long flaſhes may be produced in rarefied air, it by no means follows, that the ſame may not alſo be produced in denſer air. As little can we infer any thing from the colours; for we obſerve the electric ſpark ſometimes white, ſometimes blue, and ſometimes purple, in the very ſame ſtate of the atmoſphere, and from the ſame ſubſtance.

The aurora borealis is ſaid to be attended with a peculiar hiſſing noiſe in ſome very cold climates; Gmelin ſpeaks of it in the moſt pointed terms, as frequent and very loud in the north-eaſtern parts of Siberia; and other travellers have related ſimilar facts. Gmelin's account is very remarkable. "Theſe northern lights (ſays he) begin with ſingle bright pillars, riſing in the north, and almoſt at the ſame time in the north-eaſt, which gradually increaſing, comprehend a large ſpace of the heavens, ruſh about from place to place with incredible velocity, and finally almoſt cover the whole

Aurora Borealis. sky up to the zenith. The streams are then seen meeting together in the zenith, and produce an appearance as if a vast extent was expanded in the heavens, glittering with gold, rubies, and sapphire. A more beautiful spectacle cannot be painted; but whoever should see such a northern light for the first time, could not behold it without terror. For however fine the illumination may be, it is attended, as I have learned from the relation of many persons, with such a hissing, cracking, and rushing noise throughout the air, as if the largest fireworks were playing off. To describe what they then hear, they make use of the expression, *Spolochi chodjat*, that is, 'the raging host is passing.' The hunters who pursue the white and blue foxes on the confines of the Icy sea, are often overtaken in their course by these northern lights. Their dogs are then so much frightened, that they will not move, but lie obstinately on the ground till the noise has passed. Commonly clear and calm weather follows this kind of northern lights. I have heard this account, not from one person only, but confirmed by the uniform testimony of many, who have spent part of several years in these very northern regions, and inhabited different countries from the Yenesei to the Lena; so that no doubt of its truth can remain. This seems indeed to be the real birthplace of the *aurora borealis*."

The hissing or rushing noise above described, Dr Blagden is inclined to attribute to small streams of electric matter running off to the earth from the masses or accumulations of electricity by which the northern lights are supposed to be produced.

6 Aurora borealis succeeded by south-west winds.

We shall conclude this article with an account of a paper presented to the Royal Society by Mr Winn, in 1772, wherein he says that the appearance of an aurora borealis is a certain sign of a hard gale of wind from the south or south-west. This he never found to fail in 23 instances; and even thinks, that from the splendour of the meteor, some judgment may be formed concerning the ensuing tempest. If the aurora is very bright, the gale will come on within twenty-four hours, but will be of no long duration; if the light is faint and dull, the gale will be less violent, and longer in coming on, but it will also last longer. His observations were made in the English channel, where such winds are very dangerous; and by attending to the auroræ, he says he often got easily out of it, when others narrowly escaped being wrecked. This is an exceeding useful observation for sailors: but it cannot be expected that the winds succeeding these meteors should in all places blow from the south-west; though no doubt a careful observation of what winds succeed the aurora borealis, and other meteors, in different parts of the world, might contribute in some measure to lessen the dangers of navigation.

7 Conjecture concerning the reason.

That the aurora borealis ought to be succeeded by winds, may be easily deduced from the hypothesis last mentioned. If this phenomenon is occasioned by the vast quantity of electric matter conveyed to the equatorial parts of the earth, it is certain that the earth cannot receive any great quantity of this matter at one place without emitting it at another. The electricity, therefore, which is constantly received at the equator, must be emitted nearer the poles, in order to perform its course, otherwise there could not be a constant supply of it for the common operations of nature. It is observed, that electrified bodies are always surrounded by a blast of air, which is sent forth from them in all directions; hence, if the electric matter find a more ready passage through one part of the earth than another, a wind will be found to blow from that quarter. If therefore one of these places happens to be in the Atlantic ocean near the coast of France, or in the bay of Biscay, the electric matter which has been received at the equator during an aurora borealis will be discharged there some time after, and consequently a wind will blow from that quarter, which will be from the south-west to those ships which are in the English channel. It cannot be imagined, however, that all the matter can be discharged from one place; and therefore according to the different situations of those electrical vents, winds may blow in different directions; and thus the same aurora borealis may produce a south-west wind in the English channel, and a north-west one in Scotland.

Aurum ‖ Ausi.

AURUM. See Gold, Chemistry, and Mineralogy *Index*.

This metal was introduced into medicine by the Arabians, who esteemed it one of the greatest cordials and comforters of the nerves. From them Europe received it without any diminution of its character; in foreign pharmacopœias it is still retained, and even mixed with the ingredients from which simple waters are to be distilled. But no one, it is presumed, at this time expects any singular virtues from it, since it certainly is not alterable in the human body. Mr Geoffroy, though unwilling to reject it from the cordial preparations, honestly acknowledges that he has no other reason for retaining it than complaisance to the Arabian schools. The chemists have endeavoured, by many elaborate processes, to extract what they call a sulphur or anima of gold: but no method is as yet known of separating the component parts of this metal; all the tinctures of it, and aurum potabile, which have hitherto appeared, are real solutions of it in aqua regia, diluted with spirit of wine or other liquors, and prove injurious to the body rather than beneficial. A place, however, is now given in some of the foreign pharmacopœias to the aurum fulminans; and it has of late been recommended as a remedy in some convulsive diseases, particularly in the chorea sancti viti.

Aurum Fulminans. See Chemistry *Index*.

Aurum Mosaicum. See Chemistry *Index*.

AURUNCI, in *Ancient Geography*, a people of Latium, towards Campania; the same with the Ausones, at least so intermixed as not to be easily distinguishable, though Pliny separates them.

AUSA, a town of Tarraconensis, in the middle age called *Ausona*; now *Vich de Osuna*, a town of Catalonia in Spain. E. Long. 2. 0. N. Lat. 41. 50.

AUSCH. See Auch.

AUSI, an ancient and very savage people of Libya. Herodotus tells us that they were unacquainted with marriage, and had all their women in common. The children were brought up by their mothers till they were able to walk: after which they were introduced to an assembly of the men, who met every three months; and the man to whom any child first spoke, acknowledged himself its father. They celebrated annually a feast in honour of Minerva, in which the girls divided into two companies, fought with sticks and

and ſtones, and thoſe who died of their wounds were concluded not to have been virgins.

AUSIMUM, or Auximum, an ancient Roman colony in the Picenum; now *Oſimo* or *Oſmo*, in the marquiſate of Ancona in Italy. E. Long. 15. N. Lat. 43. 20.

AUSITÆ, or Æsitæ, a tribe of ancient Arabs, ſuppoſed by Bochart to have inhabited the land of Uz mentioned in Scripture.

AUSONA, in *Ancient Geography*, a town of the Auſones, a people who anciently occupied all the Lower Italy, from the Promontorium Circæum down to the ſtraits of Sicily (Livy), but were afterwards reduced to a much narrower compaſs; namely, between the Montes Circæi and Maſſici: nor did they occupy the whole of this, but other people were intermixed. Concerning Auſona or its remains there is nothing particular recorded.

AUSONIA, the ancient name of Italy, from its moſt ancient inhabitants the Auſones, (Virgil, Servius).

AUSONEUM mare, in *Ancient Geography*, a part of the Ionian ſea, extending ſouthwards from the promontory Japygium to Sicily, which it waſhes on the eaſt, as it does the Bruttii and Magna Græcia on the ſouth and eaſt. It is ſeparated from the Tuſcan ſea by the ſtrait of Meſſina.

AUSONIUS (in *Latin*, *Decius*, or rather *Decimus*, Magnus Auſonius), one of the beſt poets of the fourth century, was the ſon of an eminent phyſician, and born at Bourdeaux. Great care was taken of his education, the whole family intereſting themſelves in it, either becauſe his genius was very promiſing, or that the ſcheme of his nativity, which had been caſt by his grandfather on the mother's ſide, made them imagine that he would riſe to great honour. He made an uncommon progreſs in claſſical learning, and at the age of 30 was choſen to teach grammar at Bourdeaux. He was promoted ſome time after to be profeſſor of rhetoric; in which office he acquired ſo great a reputation, that he was ſent for to court to be preceptor to Gratian the emperor Valentinian's ſon. The rewards and honours conferred on him for the faithful diſcharge of his office prove the truth of Juvenal's maxim, that when Fortune pleaſes, ſhe can raiſe a man from a rhetorician to the dignity of a conſul. He was actually appointed conſul by the emperor Gratian, in the year 379, after having filled other conſiderable poſts; for beſides the dignity of quæſtor, to which he had been nominated by Valentinian, he was made prefect of the prætorium in Italy and Gaul after that prince's death. His ſpeech returning thanks to Gratian on his promotion to the conſulſhip is highly commended. The time of his death is uncertain; he was ſtill living in 392, and lived to a great age. The emperor Theodoſius had a great eſteem for Auſonius, and preſſed him to publiſh his poems. There is a great inequality in his works; and in his manner and his ſtyle there is a harſhneſs which was perhaps rather the defect of the times he lived in than of his genius. Had he lived in Auguſtus's reign, his verſes, according to good judges, would have equalled the moſt finiſhed of that age. He is generally ſuppoſed to have been a Chriſtian: ſome ingenious authors indeed think otherwiſe, but, according to Mr Bayle, without juſt reaſon. The beſt edition of his poems is that of Amſterdam in 1671.

AUSPEX, a name originally given thoſe who were afterwards denominated *augurs*. In which ſenſe the word is ſuppoſed to be formed from *avis*, "bird," and *inſpicere*, "to inſpect; *auſpices*, q. d. *aviſpices*. Some will therefore have auſpices properly to denote thoſe who foretold future events from the flight of birds.

AUSPICIUM, Auspicy, the ſame with augury.

AUSTER, one of the four cardinal winds, as Servius calls them, belowing from the ſouth, (Pliny, Ovid, Manilius.)

AUSTERE, rough, aſtringent. Thus an auſtere taſte is ſuch a one as conſtringes the mouth and tongue; as that of unripe fruits, harſh wines, &c.

AUSTERITY, among moral writers, implies ſeverity and rigour. Thus we ſay, *auſterity of manners*, *auſterities of the monaſtic life*, &c.

AUSTIN, St. See *St Augustin*.

AUSTRAL, Australis, the ſame with ſouthern. The word is derived from *auſter*, "ſouth wind." Thus auſtral ſigns are the ſix laſt ſigns of the zodiac; ſo called becauſe they are on the ſouth ſide of the equinoctial.

AUSTRALIS PISCIS, the Southern Fish, is a conſtellation of the ſouthern hemiſphere, not viſible in our latitude; whoſe ſtars in Ptolemy's catalogue are 18, and in the Britannic catalogue 24.

AUSTRIA, one of the principal provinces of the empire of Germany towards the eaſt; from which ſituation it takes its name *Ooſt-rych*, in the German language ſignifying the *Eaſt Country*. It is bounded on the north by Moravia; on the eaſt by Hungary; on the ſouth by Stiria; and on the weſt by Bavaria. It is divided into *Upper* and *Lower*. Upper Auſtria is ſituated on the ſouth, and Lower Auſtria on the north ſide of the Danube. Vienna the capital is in Upper Auſtria, which contains ſeveral other very conſiderable towns. The country is very fertile, has a great many mines, and produces vaſt quantities of ſulphur.

In the ninth and tenth centuries, Auſtria was the frontier of the empire againſt the barbarians. In 928, the emperor Henry the Fowler, perceiving that it was of great importance to ſettle ſome perſon in Auſtria who might oppoſe theſe incurſions, inveſted Leopold, ſurnamed the *Illuſtrious*, with that country. Otho I. erected Auſtria into a marquiſate in favour of his brother-in-law Leopold, whoſe deſcendant Henry II. was created duke of Auſtria by the emperor Frederic Barbaroſſa. His poſterity becoming extinct in 1240, the ſtates of the country, in order to defend themſelves from the incurſions of the Bavarians and Hungarians, reſolved to put themſelves under the protection of Henry marquis of Miſnia; but Othogar II. king of Bohemia, being likewiſe invited by a party in the duchy, took poſſeſſion of it, alleging not only the invitation of the ſtates, but alſo the right of his wife, heireſs of Frederic the laſt duke. The emperor Rodolphus I. pretending a right to this duchy, refuſed to give Othogar the inveſtiture of it; and afterwards killing him in a battle, procured the right of it to his own family. From this Rhodolphus the preſent houſe of Auſtria is deſcended, which

Auftria. which for feveral centuries paft has rendered itfelf fo famous and fo powerful, having given 14 emperors to Germany, and fix kings to Spain.

In 1477, Auftria was erected into an archduchy by the emperor Frederic the Pacific for his fon Maximilian, with thefe privileges: That thefe fhall be judged to have obtained the inveftiture of the ftates, if they do not receive it after having demanded it three times; that if they receive it from the emperor, or the imperial ambaffadors, they are to be on horfeback, clad in a royal mantle, having in their hand a ftaff of command, and upon their head a ducal crown of two points, and furrounded with a crofs like that of the imperial crown. The archduke is born privy-counfellor to the emperor, and his ftates cannot be put to the ban of the empire. All attempts againft his perfon are punifhed as crimes of lefe-majefty, in the fame manner as thofe againft the king of the Romans, or electors. No one dared to challenge him to fingle combat. It is in his choice to affift at the affemblies, or to be abfent; and he has the privilege of being exempt from contributions and public taxes, excepting 12 foldiers which he is obliged to maintain againft the Turks for one month. He has rank immediately after the electors; and exercifes juftice in his ftates without appeal, by virtue of a privilege granted by Charles V. His fubjects cannot even be fummoned out of his province upon account of law-fuits, to give witnefs, or to receive the inveftiture of fiefs. Any of the lands of the empire may be alienated in his favour, even thofe that are feudal; and he has a right to create counts, barons, gentlemen, *poets*, and notaries. In the fucceffion to his ftates, the right of birth takes place; and, failing males, the females fucceed according to the lineal right, and, if no heir be found, they may difpofe of their lands as they pleafe.

Upper Auftria, properly fo called, has throughout the appearance of a happy country. Here are no figns of the ftriking contraft betwixt poverty and riches which offends fo much in Hungary. All the inhabitants, thofe of the capital only excepted, enjoy that happy mediocrity which is the confequence of a gentle and wife adminiftration. The farmer has property; and the rights of the nobility, who enjoy a kind of lower judicial power, are well defined. The fouth and fouth-weft parts of the country are bounded by a ridge of hills, the inhabitants of which enjoy a fhare of profperity unknown to thofe of the interior parts of France. There are many villages and market towns, the inhabitants of which have bought themfelves off from vaffalage, are now their own governors, and belong fome of them to the eftates of the country. The cloifters, the prelates of which belong to the eftates of the country, are the richeft in Germany, after the immediate prelacies and abbacies of the empire. One of the greateft convents of Benedictines is worth upwards of 4000 millions of French livres, half of which goes to the exchequer of the country.

Lower Auftria yearly exports more than two millions guilders worth of wine to Moravia, Bohemia, Upper Auftria, Bavaria, Saltzburgh, and part of Stiria and Carinthia. This wine is four, but has a great deal of ftrength, and may be carried all over the world without danger; when it is ten or twenty years old it is very good. This country is very well peopled. Mr Schloffer, in his Political Journal, which contains an account of the population of Auftria, eftimates that of this country at 2,100,000 men. The revenue amounts to about 14,000,000 of florins, of which the city of Vienna contributes above five, as one man in the capital earns as much as three in the country.

The fouthern parts of Auftria are covered with hills, which rife gradually from the banks of the Danube to the borders of Stiria, and are covered with woods. They lofe themfelves in the mafs of mountains which run to the fouth of Germany, and ftretch through all Stiria, Carniola, Carinthia, and Tyrol, to the Swifs Alps; and are probably, after Savoy and Switzerland, the higheft part of the earth. The inhabitants of this extenfive ridge of mountains are all very much alike; they are a ftrong, large, and, the GOITRES excepted, a very handfome people.

The characteriftic of the inhabitants of all this country is ftriking bigotry, united with ftriking fenfuality. You need only fee what is going forwards here to be convinced that the religion taught by the monks is as ruinous to the morals as it is repugnant to Chriftianity. The Cicifbeos accompany the married women from their bed to church, and lead them to the very confeffional. The bigotry of the public in the interior parts of Auftria, which from the mixture of gallantry with it, is ftill to be found even amongft people of rank, degenerates amongft the common people into the groffeft and moft abominable buffoonery. The Windes, who are mixed with the Germans in thefe countries, diftinguifh themfelves by a fuperftitious cuftom that does little honour to the human underftanding, and would be incredible if we had not the moft unequivocal proofs of the fact before our eyes. Many years ago, they fet out in company with fome Hungarian enthufiafts to Cologne on the Rhine, which is about 120 German miles diftant, to cut off the beard of a crucifix there. Every feven years this operation is repeated, as in this fpace of time the beard grows again to its former length. The rich perfons of the affociation fend the poorer ones as their deputies, and the magiftrates of Cologne receive them as ambaffadors from a foreign prince. They are entertained at the expence of the ftate, and a counfellor fhows them the moft remarkable things in the town. This farce brings in large fums of money at ftated times, and may therefore deferve political encouragement; but ftill, however, it is the moft miferable and meaneft way of gain that can be imagined. Thefe Windes have alone the right to fhave our Saviour, and the beard grows only for them. They firmly believe, that if they did not do this fervice to the crucifix the earth would be fhut to them for the next feven years, and there would be no harvefts. For this reafon they are obliged to carry the hair home with them, as the proof of having fulfilled their commiffion, the returns of which are diftributed among the different communities, and preferved as holy relics. The imperial court has for a long time endeavoured in vain to prevent this emigration, which deprives agriculture of fo many ufeful hands. When the Windes could not go openly, they would go clandeftinely. At length the court thought of the expedient of forbidding the regency of Cologne to let them enter the town. This happened fix years ago, and the numerous embaffy was-

was obliged to beg its way back again without the wonderful beard; which without doubt the Capuchins, to whom the crucifix belonged, used to put together from their own. The trade which the monks carry on with holy salves, oils, &c. is still very considerable; a prohibition of the court, lately published, has rather lessened it, but it cannot be entirely suppressed till next generation. It is now carried on secretly, but perhaps to nearly as great an amount as formerly.

AUSTROMANCY, Austromantia, properly denotes soothsaying, or a vain method of predicting futurity, from observations of the winds.

AUTERFOITS acquit.
Auterfoits Attaint.
Auterfoits Acquit.
} See the article *Plea to Indictment.*

AUTHENTIC, something of acknowledged and received authority. In *Law*, it signifies something clothed in all its formalities, and attested by persons to whom credit has been regularly given. Thus we say, *authentic papers*, *authentic instruments*.

AUTHOR, properly signifies one who created or produced any thing. Thus God, by way of eminence, is called the *Author of nature*, the *Author of the universe*.

Author, in matters of literature, a person who has composed some book or writing.

AUTHORITY, in a general sense, signifies a right to command, and make one's self obeyed. In which sense we say, *the royal authority*, *the episcopal authority*, *the authority of a father*, &c. It denotes also the testimony of an author, some apophthegm or sentence of an eminent person quoted in a discourse by way of proof.

Authority is represented, in painting, like a grave matron sitting in a chair of state, richly clothed in a garment embroidered with gold, holding in her right hand a sword, and in her left a sceptre. By her side is a double trophy of books and arms.

AUTOCHTHONES, an appellation assumed by some nations, importing that they sprung, or were produced, from the same soil which they still inhabited. In this sense, *Autochthones* amounts to the same with *Aborigines*. The Athenians valued themselves on their being Autochthones, *self-born*, or γηγενεις, *earth-born*; it being the prevailing opinion among the ancients, that, in the beginning, the earth, by some prolific power, produced men, as it still does plants. The proper Autochthones were those primitive men who had no other parent beside the earth. But the name was also assumed by the descendants of these men, provided they never changed their ancient state, nor suffered other nations to mix with them. In this sense it was that the Greeks, and especially the Athenians, pretended to be Autochthones; and as a badge thereof, wore a golden grasshopper woven in their hair, an insect supposed to have the same origin.

AUTOCRATOR, a person vested with an absolute independent power, by which he is rendered unaccountable to any other for his actions. The power of the Athenian generals, or commanders, was usually limited; so that, at the expiration of their office, they were liable to render an account of their administration. But, on some extraordinary occasions, they were exempted from this restraint, and sent with a full and uncontroulable authority: in which sense they were styled Αυτοκρατορες. The same people also applied the name to some of their ambassadors, who were vested with a full power of determining matters according to their own discretion. These were denominated Πρεσβεις Αυτοκρατορες, and resembled our plenipotentiaries.

AUTO da fe, act of faith. See *Act of Faith*.

AUTODIDACTUS, a person self-taught, or who has had no master or assistant of his studies besides himself.

AUTOGRAPH, denotes a person's hand-writing, or the original manuscript of any book, &c.

AUTOLITHOTOMUS, he who cuts himself for the stone. Of this we have a very extraordinary instance given by Reiselius, in the Ephemerides of the Academy *Naturæ Curiosorum*, dec. 1. an. 3. obs. 192.

AUTOMATE, called also *Hiera*, one of the Cyclades, an island to the north of Crete (Pliny), said to have emerged out of the sea, between the islands Thera and Therasia, in the fifth year of the emperor Claudius; in extent 30 stadia, (Orosius).

AUTOMATON, (from αυτος *ipse*, and μαομαι *excitor*) a self-moving machine, or one so constructed, by means of weights, levers, pulleys, &c. as to move for a considerable time, as though endowed with animal life. According to this description, clocks, watches, and all machines of that kind, are automata.

Under the article Androides we observed that the highest perfection to which automata could be carried was to imitate exactly the motions and actions of living creatures, especially of mankind, which are more difficultly imitated than those of other animals. Very surprising imitations, however, have been made of other creatures. So long ago as 400 years before Christ, Archytas of Tarentum is said to have made a wooden pigeon that could fly; nor will this appear at all incredible, when we consider the flute-player made by M. Vaucanson, and the chess-player by M. Kempell. Dr Hook is also said to have made the model of a flying chariot, capable of supporting itself in the air. But M. Vaucanson above-mentioned hath distinguished himself still more eminently. That gentleman, encouraged by the favourable reception of his flute-player, made a duck, which was capable of eating, drinking, and imitating exactly the voice of a natural one. Nay, what is still more surprising, the food it swallowed was evacuated in a digested state; not that it was really in a state of natural excrement, but only considerably altered from what it was when swallowed; and this digestion was performed on the principles of solution, not of trituration. The wings, viscera, and bones, of this artificial duck, were also formed so as very strongly to resemble those of a living animal. Even in the actions of eating and drinking, this resemblance was preserved; the artificial duck swallowed with avidity and vastly quick motions of the head and throat; and likewise muddled the water with its bill, exactly like a natural one.

M. le Droz of La Chaux de Fonds in the county of Neufchattel, hath also executed some very curious pieces of mechanism, which well deserve to be ranked with those already mentioned. One was a clock, which was presented to his Spanish majesty; and had among other curiosities, a sheep, which imitated the bleating of a natural one; and a dog watching a basket of fruit. When any one attempted to purloin the fruit, the dog gnashed

gnashed his teeth and barked; and if it was actually taken away he never ceased barking till it was restored. Besides this, he made a variety of human figures, which exhibited motions truly surprising; but all inferior to Mr Kempell's chess-player, which may justly be looked upon as the greatest masterpiece in mechanics that ever appeared. See ANDROIDES.

AUTONOMIA, a power of living or being governed by our own laws and magistrates. The liberty of the cities which lived under the faith and protection of the Romans, consisted in their autonomia, i. e. they were allowed to make their own laws, and elect their own magistrates; by whom justice was to be administered, and not by Roman presidents or judges, as was done in other places which were not indulged the autonomia.

AUTOPYROS, from αὐτος, and πυρος, *wheat*; in the ancient diet, an epithet given to a species of bread, wherein the whole substance of the wheat was retained without retrenching any part of the bran. Galen describes it otherwise, viz. as bread where only the coarser bran was taken out.—And thus it was a medium between the finest bread, called *similagineus*, and the coarsest called *furfuraceus*. This was also called *autopyrites* and *syncomistus*.

AUTRE-EGLISE, a village of Brabant, in the Austrian Netherlands; to which the left wing of the French army extended, when the confederates obtained the victory at Ramillies, in 1706. E. Long. 4. 50. N. Lat. 50. 40.

AUTRICUM, the capital of the Carnutes, a people of Gallia Celtica; afterwards called *Carnotena*, *Carnotenus*, and *Civitas Carnotenum*: Now *Chartres*, in the Orleanois on the Eure. E. Long. 1. 32. N. Lat. 48. 47.

AUTUMN, the third season of the year, when the harvest and fruits are gathered in. Autumn is represented in painting, by a man at perfect age, clothed like the vernal, and likewise girded with a starry girdle; holding in one hand a pair of scales equally poised, with a globe in each; in the other hand a bunch of divers fruits and grapes. His age denotes the perfection of this season; and the balance, that sign of the zodiac which the sun enters when our autumn begins.

Autumn begins on the day when the sun's meridian distance from the zenith, being on the decrease, is a mean between the greatest and the least; which in these countries is supposed to happen when the sun enters Libra. Its end coincides with the beginning of winter. Several nations have computed the years by autumns; the English Saxons, by winters. Tacitus tells us, the ancient Germans were acquainted with all the other seasons of the year, but had no notion of autumn. Lidyat observes of the beginning of the several seasons of the year, that

Dat Clemens hyemem, dat Petrus ver cathedratus,
Æstuat Urbanus, autumnat *Bartholomæus*.

Autumn has always been reputed an unhealthy season, Tertullian calls it *tentator valetudinum*; and the satyrist speaks of it in the same light. *Autumnus Libitinæ questus acerbæ.*

AUTUMNAL POINT, is that part of the equinox from which the sun begins to descend towards the south pole.

AUTUMNAL Signs, in *Astronomy*, are the signs Libra, Scorpio, Sagittarius, through which the sun passes during the autumn.

AUTUMNAL Equinox, that time when the sun enters the autumnal point.

AUTUN, an ancient city of France, in the department of Saone and Loire, formerly the duchy of Burgundy, the capital of the Autonois, with a bishop's see. The length of this city is about three quarters of a mile, and its breadth nearly equal. The river Arroux washes its ancient walls, whose ruins are so firm, and the stone so closely united, that they seem almost to be cut out of the solid rock. In this city are the ruins of three ancient temples, one of which was dedicated to Janus, and another to Diana. Here are likewise a theatre and a pyramid, which last is probably a tomb; it stands in a place called the *field of urns*, because several urns had been found there. Here are also two antiques gates of great beauty. The city lies at the foot of three great mountains, in E. Long. 4. 15. N. Lat. 45. 50.

AUTURA, or AUDURA, a river of Gallia Celtica, only mentioned in the Lives of the Saints. Now the *Eure*, which falls into the Seine, on the left-hand or south side.

AUVERGNE, a late province of France, about 100 miles in length and 75 in breadth. It is bounded on the north by the Bourbonnois; on the east by Torez and Velay; on the west, by Limosin, Quercy, and La Marche; and on the south, by Rovergne and the Cevennes. It is divided into upper and lower; the latter, otherwise called *Limagne*, is one of the finest countries in the world. The mountains of Higher Auvergne render it less fruitful; but they afford good pasture, which feeds great numbers of cattle, which are the riches of that country. Auvergne supplies Lyons and Paris with fat cattle, makes a large quantity of cheese, and has manufactures of several kinds. The capital of the whole province is Clermont. It is now divided into the departments of Cantal and Puy de Dome.

AUVERNAS, a very deep-coloured heady wine, made of black raisins so called, which comes from Orleans. It is not fit to drink before it is above a year old; but if kept two or three years, it becomes excellent.

AUXERRE, an ancient town of France in the department of Yonne, and capital of the Auxerrois, and lately a bishop's see. The episcopal palace was one of the finest in France, and the churches were also very beautiful. This town is advantageously situated for trade with Paris, on the river Yonne. E. Long. 3. 35. N. Lat. 47. 54.

AUXESIS, in *Mythology*, a goddess worshipped by the inhabitants of Egina, and mentioned by Herodotus and Pausanias.

AUXESIS, in *Rhetoric*, a figure whereby any thing is magnified too much.

AUXILIARY, whatever is aiding or helping to another.

AUXILIARY Verbs, in *Grammar*, are such as help to form or conjugate others; that is, are prefixed to them, to form or denote the modes or tenses thereof; as, *to have* and *to be*, in the English; *etre* and *avoir*, in the French; *ho* and *sono* in the Italian, &c. In the English language,

language, the auxiliary verb *am* ſupplies the want of paſſive verbs.

AUXO, in *Mythology*, the name of one of two Graces worſhipped by the Athenians. See HEGEMONE.

AUXONNE, a ſmall fortified town in France, in the department of Cote d'Or; ſeated on the river Saone, over which there is a bridge of 23 arches, to facilitate the running off of the waters after the overflowing of the river. At the end of the bridge is a cauſeway 2250 paces long. E. Long. 5. 22. N. Lat. 47. 11.

AUXY; the French give the name of *auxy wool* to that which is ſpun in the neighbourhood of Abbeville, by thoſe workmen who are called *houpiers*. It is a very fine and beautiful wool, which is commonly uſed to make the fineſt ſtockings.

AWARD, in *Law*, the judgment of an arbitrator, or of one who is not appointed by the law a judge, but choſen by the parties themſelves for terminating their difference. See ARBITER and ARBITRATION.

AWL, among *Shoemakers*, an inſtrument wherewith holes are bored through the leather, to facilitate the ſtitching or ſewing the ſame. The blade of the awl is uſually a little flat and bended, and the point ground to an acute angle.

AWLAN, a ſmall imperial town of Germany, in the circle of Suabia, ſeated on the river Kochen. E. Long. 11. 15. N. Lat. 48. 52.

AWME, or AUME, a Dutch liquid meaſure containing eight ſteckans, or 20 verges or verteels, equal to the tierce in England, or to one-ſixth of a ton of France.

AWN. See ARISTA, BOTANY *Index*.

AWNING, in the *Sea-Language*, is the hanging a ſail, tarpawling, or the like, over any part of the ſhip, to keep off the ſun, rain, or wind.

AX, a carpenter's inſtrument, ſerving to hew wood. The ax differs from the joiner's hatchet, in that it is made larger and heavier, as ſerving to hew large ſtuff; and its edge tapering into the middle of its blade. It is furniſhed with a long handle or helve, as being to be uſed with both hands.

Battle-Ax. See CELT.

AXAMENTA, in *Antiquity*, a denomination given to the verſes or ſongs of the *ſalii*, which they ſung in honour of all men. The word is formed, according to ſome, from *axare*, q. d. *nominare*. Others will have the *carmina ſaliaria* to have been denominated *axamenta*, on account of their having been written in *axibus*, or on wooden tables.

The *axamenta* were not compoſed, as ſome have aſſerted, but only ſung by the *ſalii*. The author of them was Numa Pompilius; and as the ſtyle might not be altered, they grew in time ſo obſcure, that the *ſalii* themſelves did not underſtand them. Varro ſays they were 700 years old. Quint. Inſt. Or. lib. i. c. 11.

AXAMENTA, or *Aſſamenta*, in *Ancient Muſic*, hymns or ſongs performed wholly with human voices.

AXAYACATL, the name of a ſpecies of fly, common in Mexico, about the lake; the eggs of which being depoſited in immenſe quantities, upon the ruſhes and corn-flags, form large maſſes, which are taken up by fiſhermen and carried to market for ſale. This caviare, called *ahuauhtli*, which has much the ſame taſte with the caviare of fiſh, uſed to be eaten by the Mexicans, and is now a common diſh among the Spaniards. The Mexicans eat not only the eggs, but the flies themſelves, made up together into a maſs, and prepared with ſaltpetre.

AXATI, a town of ancient Bætica, on the Bætis; now *Lora*, a ſmall city of Andaluſia, in Spain, ſeated on the Gaudalquiver. W. Long. 5. 20. N. Lat. 37. 20.

AXBRIDGE, a town of Somerſetſhire in England, conſiſting of one long narrow ſtreet. W. Long. 2. 20. N. Lat. 51. 30.

AXEL, a ſmall fortified town in Dutch Flanders. E. Long. 40. 0. N. Lat. 51. 17.

AXHOLM, an iſland in the north-weſt part of Lincolnſhire in England. It is formed by the rivers Trent, Idel, and Dan; and is about ten miles long and five broad. The lower part is marſhy, but produces an odoriferous ſhrub called *gall;* the middle is rich and fruitful, yielding flax in great abundance, as alſo alabaſter which is uſed for making lime. The principal town is called *Axey*, and is now very thinly inhabited.

AXIACE, an ancient town of Sarmatia Europea; now *Oczakow*, the capital of Budziac Tartary. E. Long. 32. 30. N. Lat. 46. 0.

AXILLA, in *Anatomy*, the arm-pit or the cavity under the upper part of the arm.

AXILLA, in *Botany*, is the ſpace comprehended between the ſtems of plants and their leaves. Hence we ſay thoſe flowers grow in the axillæ of the leaves; *i. e.* at the baſe of the leaves, or juſt within the angle of their pedicles.

AXILLARY, ſomething belonging to or lying near the axilla. Thus, *axillary artery* is that part of the ſubclavian branches of the aſcending trunk of the aorta which paſſeth under the arm-pits; *axillary glands* are ſituated under the arm-pits, enveloped in fat, and lie cloſe by the axillary veſſels; and *axillary vein* is one of the ſubclavians which paſſes under the arm-pit, dividing itſelf into ſeveral branches, which are ſpread over the arm.

AXIM, a ſmall territory on the Gold-coaſt in Africa. The climate here is ſo exceſſively moiſt, that it is proverbially ſaid to rain 11 months and 29 days of the year. This exceſſive moiſture renders it very unhealthy; but it produces great quantities of rice, water melons, lemons, oranges, &c. Here are alſo produced vaſt numbers of black cattle, goats, ſheep, tame pigeons, &c. The whole country is filled with beautiful and populous villages, and the intermediate lands well cultivated; beſides which, the natives are very wealthy, from the conſtant traffic carried on with them by the Europeans for their gold. The capital, which is alſo called *Axim*, by ſome *Achombone*, ſtands under the cannon of the Dutch fort St Antonio. Behind, it is ſecured by a thick wood that covers over the whole declivity of a neighbouring hill. Between the town and the ſea runs an even and ſpacious ſhore of beautiful white ſand. All the houſes are ſeparated by groves of cocoa and other fruit trees, planted in parallel lines, each of an equal width, and forming an elegant viſta. The little river Axim croſſes the town; and the coaſt is defended by a number of ſmall pointed rocks, which project from the ſhore, and render all acceſs to it dangerous. The capital is ſituated in W. Long. 24. 0. N. Lat 5. 0. This canton is a kind of republic, the government being

being divided between the Caboceroes or chief men, and Manaceros or young men. It muſt be obſerved, however, that in their courts there is not even a pretence of juſtice: whoever makes the moſt valuable preſents to the judges is ſure to gain his cauſe, the judges themſelves alleging the gratitude due for the bribes received as a reaſon: and if both parties happen to make preſents of nearly equal value, they abſolutely refuſe to give the cauſe a hearing.

AXINOMANCY, Axinomantia, from ἀξίνη, *ſecuris*, and μαντεία, *divinatio*; an ancient ſpecies of divination, or a method of foretelling future events by means of an ax or hatchet.—This art was in conſiderable repute among the ancients; and was performed, according to ſome, by laying an agate-ſtone on a red-hot hatchet; and alſo by fixing a hatchet on a round ſtake ſo as to be exactly poiſed; then the names of thoſe that were ſuſpected were repeated, and he at whoſe name the hatchet moved was pronounced guilty.

AXIOM, Axioma (from ἀξιόω, *I am worthy*); a ſelf-evident truth, or a propoſition whoſe truth every perſon perceives at firſt ſight. Thus, that the whole is greater than a part; that a thing cannot be and not be at the ſame time; and that from nothing, nothing can ariſe; are axioms.

Axiom is alſo an eſtabliſhed principle in ſome art or ſcience. Thus, it is an axiom in phyſics, that nature does nothing in vain; that effects are proportional to their cauſes, &c. So it is an axiom in geometry, that things equal to the ſame thing are alſo equal to one another; that if to equal things you add equals, the ſums will be equal, &c. It is an axiom in optics, that the angle of incidence is equal to the angle of reflection, &c.

AXIPOLIS, a town of the Triballi in Mæſia Inferior; now *Axiopoli*, in Bulgaria. E. Long. 34. 0. N. Lat. 45. 40.

AXIS, in *Geometry*, the ſtraight line in a plain figure, about which it revolves, to produce or generate a ſolid. Thus, if a ſemicircle be moved round its diameter at reſt, it will generate a ſphere, the axis of which is that diameter.

Axis, in *Aſtronomy*, is an imaginary right line ſuppoſed to paſs through the centre of the earth and the heavenly bodies, about which they perform their diurnal revolutions.

Axis, in *Conic Sections*, a right line dividing the ſection into two equal parts, and cutting all its ordinates at right angles.

Axis, in *Mechanics*. The axis of a balance is that line about which it moves, or rather turns about. *Axis of oſcillation*, is a right line parallel to the horizon, paſſing through the centre about which a pendulum vibrates.

Axis in Peritrochio, one of the ſix mechanical powers, conſiſting of a peritrochium or wheel concentric with the baſe of a cylinder, and moveable together with it about its axis.

Axis, in *Optics*, is that particular ray of light coming from any object which falls perpendicularly on the eye.

Axis, in *Architecture*. *Spiral axis*, is the axis of a twiſted column drawn ſpirally in order to trace the circumvolutions without. *Axis of the Ionic capital*, is a line paſſing perpendicularly through the middle of the eye of the volute.

Axis of a Veſſel, is an imaginary right line paſſing through the middle of it perpendicularly to its baſe, and equally diſtant from its ſides.

Axis, in *Botany*, is a taper column placed in the centre of ſome flowers or catkins, about which the other parts are diſpoſed.

Axis, in *Anatomy*, the name of the ſecond vertebra of the neck; it hath a tooth which goes into the firſt vertebra, and this tooth is by ſome called the *axis*.

AXMINSTER, a town of Devonſhire, ſituated on the river Ax, in the great road between London and Exeter, in W. Long. 3. 15. N. Lat. 50. 40. It was a place of ſome note in the time of the Saxons, but now contains only about 200 houſes. Here is a ſmall manufactory of broad and narrow cloths, and ſome carpets are alſo manufactured after the Turkey manner.

AXOLOTLF. See Lacerta.

AXUMA, formerly a large city, and capital of the whole kingdom of Abyſſinia in Africa, but now reduced to a miſerable village ſcarcely containing 100 inhabitants. E. Long. 36. 4. N. Lat. 14. 13.

AXUNGIA, in a general ſenſe, denotes old lard, or the drieſt and hardeſt of any fat in the bodies of animals: but more properly it ſignifies only hog's lard.

Axungia Vitri, Sandiver, or *Salt of Glaſs*, a kind of ſalt which ſeparates from the glaſs while it is in fuſion. It is of an acrimonious and biting taſte. The farriers uſe it for cleanſing the eyes of horſes. It is alſo made uſe of for cleanſing the teeth; and it is ſometimes applied to running ulcers, the herpes, or the itch, by way of deſiccative.

AXYRIS. See Botany *Index*.

AY, a town of France in Champagne, near the river Maine, remarkable for its excellent wines. E. Long. 2. 15. N. Lat. 49. 4.

AYAMONTE, a ſea-port town of Andaluſia in Spain, with a ſtrong caſtle built on a rock; ſeated on the mouth of the river Gaudiana. It has a commodious harbour, fruitful vineyards, and excellent wine. W. Long. 8. 5. N. Lat. 37. 9.

AYENIA. See Botany *Index*.

AYLESBURY. See Ailesbury. This place gave title of earl to the noble family of Bruce, now to a branch of Brudenals by ſucceſſion.

AYLMER, John, biſhop of London, in the reign of Queen Elizabeth, was born in the year 1521, at Aylmer-hall in the pariſh of Tilney, in the county of Norfolk. Whilſt a boy, he was diſtinguiſhed for his quick parts by the marquis of Dorſet afterwards duke of Suffolk; who ſent him to Cambridge, made him his chaplain and tutor to his children. One of theſe children was the unfortunate Lady Jane Gray, who ſoon became perfectly acquainted with the Latin and Greek languages. His firſt preferment was to the archdeaconry of Stow, in the dioceſe of Lincoln, which gave him a ſeat in the convocation held in the firſt year of Queen Mary, where he reſolutely oppoſed the return to Popery, to which the generality of the clergy were inclined. He was ſoon after obliged to fly his country, and take ſhelter among the Proteſtants in Switzerland. On the acceſſion of Queen Elizabeth, he returned to England. In 1562, he obtained the archdeaconry

Ayr. deaconry of Lincoln; and was a member of the famous synod of that year, which reformed and settled the doctrine and discipline of the church of England. In the year 1576, he was consecrated bishop of London. He died in the year 1594, aged 73; and was buried in St Paul's. He was a learned man, a zealous father of the church, and a bitter enemy to the Puritans. He published a piece entitled, *An harbrowe for faithful and trewe subjects against the late blowne blaste concerning the government of women*, &c. This was written whilst he was abroad in answer to Knox, who published a book in Geneva under this title, *The first blast against the monstrous regiment and empire of women.* He is by Strype supposed to have published Lady Jane Gray's letter to Harding. He also assisted Fox in translating his History of Martyrs into Latin.

AYR, a royal borough, of great antiquity, and considerable extent, the county town of Ayrshire, and the seat of a justiciary court. It was erected into a royal borough by William the Lion, about the year 1180; and the privileges granted by that charter are still enjoyed by the town. It is pleasantly situated on a point of land, between the influx of the rivers Doon and Ayr, into the Atlantic ocean. The principal street is a fine ornamented, broad, spacious way, with a row of elegant houses on each side. Its shape is somewhat of the form of a crescent, having the tolbooth and town-hall in the centre, with a fine spire, 135 feet high. In ancient times we find Ayr to have been a town of considerable trade. The merchants imported a great quantity of wine from France, and exported corn and other produce of the country. The rising trade of Glasgow proved very injurious to the trade of this town; but of late it has much revived. The sea shore is flat and shallow, and the entrance of the river Ayr, which forms the harbour, is subject to the inconvenience of a bar of sand, which is often thrown quite across the river, especially with a strong north-west wind. The water never rises above twelve feet; but from some improvements and extensive works now carrying on on the sides of the river, it is hoped the channel will be considerably deepened. There are erected two reflecting light-houses to conduct vessels safely into the harbour. There is great plenty of salmon in the two rivers, the fishings of which rent at upwards of 200l. Besides the salmon fishery, the sand banks on the coast abound with all kinds of white fish; and one or two companies are established here for curing them. The principal trade carried on is the exportation of coal to Ireland, in which nearly 2000 tonnage of vessels are annually employed. There is an extensive manufacture of leather and soap. Ayr was in ancient times, however, not only distinguished for trade, but also for military strength. Here the heroic exploits of Sir William Wallace began, and here Edward I. fixed one of his most powerful garrisons. Oliver Cromwell, too, judging it a proper place to build a fortress, took possession of the old church, and converted it and the neighbouring ground into a regular citadel. On one of the mounts, within the walls of this fortress, stood the old castle of Ayr, mentioned in ancient histories, and the old church, the tower of which still remains, noted for the meeting of the Scotish parliament, when Robert Bruce's title to the throne was unanimously confirmed. Ayr is a very gay and fashionable place. It has well attended races, and is sometimes the seat of the Caledonian hunt. In 1797, the population amounted to 4647; in 1801, 5560. There is a strong chalybeate spring, which is famous in scrophulous and scorbutic complaints. Tradition reports an engagement to have taken place in the valley of Dalrymple, between two kings, Fergus and Coilus, in which both leaders lost their lives; the names of places in the neighbourhood seem derived from this circumstance, and a cairn of stones in the midst of the valley is said to point out the place of the engagement. History has only recorded two distinguished characters in literature, natives of Ayr: 1st, Johannes Scotus, surnamed *Erigena*, celebrated for his acumen of judgment, his readiness of wit, and fluency of elocution: and, 2d, the Chevalier Ramsay, author of Cyrus' Travels, and other works. To these we may add the late Robert Burns, whose genius, at least, will bear a comparison with any of the former.

Ayr, Ayrshire.

AYR, *Newton of.* While the borough of Ayr extends along the south side of the river Ayr, this small parish is situated on the north side of the same river. It is a burgh of considerable domain, having in that domain baronial jurisdiction; governed by a magistracy elected by free-men, but not having parliamentary representation. It is of very ancient erection, owing its privileges to Robert Bruce, who, upon being attacked with leprosy, came to reside in this place, and was induced to establish a lazar-house, and to confer considerable favours on the town, and on the small village of Priestwick, about two or three miles distant. In the Newton of Ayr are a number of very good houses. It has a tolerable good harbour, chiefly employed in the coal trade. Lying on the banks of Ayr, and the sea coast; the soil is mostly flat and sandy. Its extent is about three miles long, and one and a half broad. In 1793, the population was 1680.

AYR, a river in the parish of Muirkirk, in Ayrshire; which after a course of about eighteen miles nearly due west falls into the sea at Ayr, where its æstuary forms a fine harbour. It is for a considerable course only a small rivulet; but joined by the Greenock and Garpel, tributary streams, it becomes a large body of water. It frequently shifts its bed, and does considerable damage by its encroachments. Its banks are steep and very romantic; and the number of seats which ornament them present a fine picturesque scenery. Sorn-castle, Auchincruive, and Auchinleck, may be mentioned as the chief beauties of the scene. The village of Catrine is situated on its banks. It forms the boundary between the districts of Ayrshire, denominated Kyle and Carrick.

AYRSHIRE, a county of Scotland, which is bounded on the north by the county of Renfrew; on the east by the shires of Lanark and Dumfries; on the south by Galloway; and on the west by the Irish channel, and the frith of Clyde. Its extent in length is about 65 miles, and about 36 in breadth. It is divided into three great districts or stewarties, which bear the names of Kyle, Cunningham, and Carrick. These divisions are not altogether artificial; the river Ayr, on which is the town of Ayr, forming the separation between Carrick and Kyle (or Ayrshire Proper), and the river Irvine (at the mouth of which is a borough of the same name) is the limit between Kyle and Cunningham.

Ayrſhire. Theſe diſtricts are very different from each other in appearance. Carrick, and the interior parts of Kyle, are mountainous, and more fitted for paſture; while the coaſt of Kyle, and the greater part of Cunningham, exhibit a fine level country, interſperſed with numerous villages and towns. The ſea coaſt is moſtly ſandy, with ſunk rocks, poſſeſſing ſeveral good harbours. The iſland of Ailſa is in this county. From the ridge, of which the mountains of Carrick are a part, riſe almoſt all the rivers of the ſouth of Scotland. The Tweed, the Eſk, the Nith, the Annan, the Urr, &c. flow to the eaſt and ſouth, while the Stinchar, the Girvan, the Doon, the Ayr, and the Lugar, pouring into the Iriſh channel, interſect the county of Ayr with their copious ſtreams. Beſides theſe, the Irvine and other ſmaller rivulets, water the more northerly parts of the county. Ayrſhire has two royal boroughs, viz. Ayr and Irvine; and ſeveral populous towns and villages, of which Kilmarnock, Beith, Saltcoats, Kilwinning, Largs, Girvan, and Ballantrae, are the chief. Fitted as Ayrſhire is in every reſpect for the carrying on of trade, and the extenſion of agricultural improvements, it is only of late years that much has been done in that way. Poſſeſſing valuable ſeams of excellent coal, and enriched with the returns from its exportation, little attention was paid to the culture of the ground. The eſtabliſhment of the Douglas and Heron Bank, though ruinous to the proprietors, contributed greatly to promote the improvement of Ayrſhire. The abundance of wealth which it fallaciouſly ſeemed to pour into the country, and the ready command of money it gave, ſet all the proprietors towards improving and planting their eſtates, furniſhed means for raiſing and burning lime for manure, and above all, with the money from the bank, canals and roads were opened through every part of the county. Upon the failure of that extravagant and ill-conducted ſpeculation, the proprietors of many eſtates ſaw their property brought to the hammer, and the greater part of their lands purchaſed by new proprietors. After the general diſtreſs, conſequent on ſo diſaſtrous a ſcheme, was ſomewhat relieved, the improvement which the land had received during the profuſion of money, enabled the proprietors to continue the improvement, and the new ſettlers being moſtly men of great fortune, allowed no expence to be wanting to produce the ſame end: and hence the improvement of the country was rather promoted than retarded, by an event which threatened to overwhelm not only Ayrſhire, but the greater part of Scotland, into the gulf of bankruptcy. Ayrſhire, beſides the inexhauſtible ſeams of coal with which it abounds, poſſeſſes ſeveral other valuable minerals; as freeſtone, limeſtone, ironſtone, ſeveral rich ores of lead and copper. A few curious ſpecimens are alſo to be found in the hills of Carrick, of agates, porphyries, and of calcareous petrifactions. In the pariſh of Stair, galena and plumbago have been found; and in ſeveral parts of the county is found that ſpecies of whetſtone, known by the name of *Ayr-ſtone*. There is plenty of marl in moſt of the lochs; the chief of which is Loch Doon, from which the river of that name takes its riſe. There is annually a great quantity of ſea weed thrown aſhore, from which many tons of kelp are made. All the rivers of Ayrſhire abound with ſalmon, and the coaſts are admirably adapted for the white fiſhing.

Ayrſhire, Ayry.

The following is a ſtatement of the population of this county at two different periods.

	Pariſh.	Population in 1755.	Population in 1790—1798.
	Ardroſſan	1297	1518
	Auchinleck	887	775
	Ayr	2964	4647
	Ballantrae	1049	770
5	Barr	858	750
	Beith	2064	2872
	Cumbraes	259	509
	Colmonell	1814	1102
	Coylton	527	667
10	Craigie	551	700
	Cumnock, New	1497	1200
	Cumnock, Old	1336	1632
	Dailly	839	1607
	Dalmellington	739	681
15	Dalry	1498	2000
	Dalrymple	439	380
	Dreghorn	887	830
	Dundonald	983	1317
	Dunlop	796	779
20	Fenwick	1113	1281
	Galſton	1013	1577
	Girvan	1193	1725
	Irvine	4025	4500
	Kilbirny	651	700
25	Kilbride, Weſt	885	698
	Kilmarnock	4403	6776
	Kilmaurs	1094	1147
	Kilwinning	2541	2360
	Kirkmichael	710	956
30	Kirkoſwald	1168	1335
	Largs	1164	1025
	Loudoun	1494	2308
	Mauchline	1169	1800
	Maybole	2058	3750
35	Monktown	582	717
	Muirkirk	745	1100
	Newtoun on Ayr.	581	1689
	Ochiltree	1210	1150
	Riccartoun	745	1300
40	St Quivox	499	1450
	Sorn	1494	2779
	Stair	369	518
	Stevenſtoun	1412	2425
	Stewartoun	2819	3000
45	Straitoun	1123	934
	Symington	359	610
	Tarbolton	1365	1200
	Total,	59,268	75,544
			59,268
	Increaſe,		16,276

AYRY, or Aery, *of Hawks*, a neſt or company of hawks; ſo called from the old French word *aire*, which ſignified the ſame.

AYSCUE, Sir George, a gallant Engliſh admiral, deſcended from a good family in Lincolnſhire. He obtained the honour of knighthood from King Charles I. which, however, did not withhold him from adhering to the parliament in the civil war: he was by them conſtituted admiral of the Iriſh ſeas, where he is ſaid to have done great ſervice to the Proteſtant intereſt, and to have contributed much to the reduction of the whole iſland. In 1651 he reduced Barbadoes and Virginia, then held for the king, to the obedience of the parliament: and ſoon after the reſtoration behaved with great honour in the war with the Dutch. In the famous engagement in the beginning of June 1666, when Sir George was admiral of the white ſquadron, his ſhip the Royal Prince ran upon the Gallop-ſand; where, being ſurrounded with enemies, his men obliged him to ſtrike. He went no more to ſea after this, but ſpent the reſt of his days in retirement.

AYMOUTH. See Eymouth.

AYTONIA. See Botany *Index*.

AZAB, in the Turkiſh armies, a diſtinct body of ſoldiery, who are great rivals of the Janizaries.

AZAI, a town of Touraine in France, ſeated on the river Indre. E. Long. 10. 35. N. Lat. 47. 18.

AZALEA, American Upright Honeysuckle. See Botany *Index*.

AZAMOR, a ſmall ſea-port town of the kingdom of Morocco in Africa. It is ſituated on the river Morbeya, in the province of Duguella, at ſome conſiderable diſtance from its mouth. This town, though formerly very conſiderable, is not proper for maritime commerce, becauſe the entrance of the river is dangerous. It was unſucceſsfully beſieged by the Portugueſe in 1508; it was taken, however, in 1513, by the duke of Braganza, but abandoned about the end of the 16th century. W. Long. 7. 0. N. Lat. 32. 50.

AZARAKITES, a ſect of Mahometan Arabs. See Arabia, N° 143, *et ſeq.*

AZARIAH, or Uzziah, king of Judah, ſucceeded his father Amaziah, 810 years before Chriſt. He aſſembled an army of above 300,000 men, with which he conquered the Philiſtines, and demoliſhed the walls of Gath, Jabniel, and Aſhdod; built up the walls of Jeruſalem; furniſhed the city with conduits; and planted gardens and vineyards: but at laſt, being elated with his proſperity, and reſolving to uſurp the office of high-prieſt, he was ſtruck with a leproſy, which obliged him to remain ſhut up in his palace for the reſt of his days. He died about 759 years before the Chriſtian era, and was ſucceeded by Jonathan his ſon.—There are ſeveral other perſons of this name mentioned in the ſacred Scriptures.

AZAZEL. The word relates to the hiſtory of the ſcape-goat, under the Jewiſh religion. Some call the goat itſelf by this name, as St Jerome and Theodoret. Dr Spenſer ſays, the ſcape-goat was to be ſent to Azazel; by which is meant the devil. Mr Le Clerc tranſlates it *præcipitium*, making it to be that ſteep and inacceſſible place to which the goat was ſent, and where it was ſuppoſed to periſh.

AZEKA, in *Ancient Geography*, a city of the Ammorites, in the lot of Judah; ſituated between Eleutheropolis and Ælia (Jerome); where the five kings of the Ammorites and their army were deſtroyed by hailſtones from heaven, (Joſhua).

AZEM, Asem, Assam, or Acham, a country of Aſia to the north of Ava, but which is very little known to Europeans. It is ſaid to be very fertile, and to contain mines of gold, ſilver, iron, and lead, all which belong to the king, who, in conſequence of enjoying the produce, requires no taxes from his people. They have alſo great quantities of gum lac, and coarſe ſilk. It is alſo thought that the inhabitants of Azem were long ago the inventors of cannon and gun-powder; and that from them the invention paſſed to the inhabitants of Pegu and from thence to the Chineſe.

AZIMUTH, in *Aſtronomy*, an arch of the horizon, intercepted between the meridian of the place and the azimuth, or vertical circle paſſing through the centre of the object, which is equal to the angle of the zenith, formed by the meridian and vertical circle: or it is found by this proportion, As the radius to the tangent of the latitude of the place, ſo is the tangent of the ſun's or ſtar's altitude, for inſtance, to the coſine of the azimuth from the ſouth, at the time of the equinox.

Magnetical Azimuth, an arch of the horizon intercepted between the aximuth, or vertical circle, paſſing through the centre of any heavenly body and the magnetical meridian. This is found by obſerving the object with an azimuth-compaſs.

Azimuth-Compaſs, an inſtrument for finding either the magnetical azimuth or amplitude of a heavenly object.

The learned Dr Knight invented ſome time ſince a very accurate and uſeful ſea-compaſs, which is at preſent uſed in the navy. This inſtrument, with another invented by the ingenious Mr Smeaton, anſwers the purpoſes of an azimuth amplitude compaſs. See Compass.

Azimuth Circles, called alſo *azimuths*, or *vertical circles*, are great circles of the ſphere interſecting each other in the zenith and nadir, and cutting the horizon at right angles. Theſe azimuths are repreſented by the rhumbs on common ſea-charts, and on the globe they are repreſented by the quadrant of altitude, when ſcrewed in the zenith. On theſe azimuths is reckoned the height of the ſtars and of the ſun when not in the meridian.

AZMER, a town of the Eaſt Indies in the dominions of the Great Mogul, capital of a province of the ſame name, with a very ſtrong caſtle. It is pretty large, and ſometimes viſited by the Mogul himſelf. It is about 62 leagues diſtant from Agra. The principal trade of this province is in ſaltpetre.

ASOGA ships, are thoſe Spaniſh ſhips commonly called the *quickſilver ſhips*, from their carrying quickſilver to the Spaniſh Weſt Indies, in order to extract the ſilver out of the mines of Mexico and Peru. Theſe ſhips, ſtrictly ſpeaking, are not to carry any goods unleſs for the king of Spain's account.

AZONI, in *Ancient Mythology*, a name applied by the Greeks to ſuch of the gods as were deities at large, not appropriated to the worſhip of any particular town or country, but acknowledged in general by all countries, and worſhipped by every nation. Theſe the Latins called *dii communes*. Of this ſort were the Sun, Mars, Luna, &c.

AZORES, iſlands in the Atlantic ocean, lying between 25 and 33 degrees of weſt longitude, and between 36 and 40 degrees of north latitude. They belong to the Portugueſe, and are alſo called the

Weſtern Iſles, on account of their ſituation. They were diſcovered by the Flemings in the 15th century. They are ſeven in number, viz. Tercera, St Michael's, St Mary's, Gracioſa, St George's Iſland, Pico, and Fayal.

AZOTH, in *Ancient Chemiſtry*, the firſt matter of metals, or the mercury of a metal; more particularly that which they call the *mercury of philoſophers*, which they pretended to draw from all ſo ts of metallic bodies.

AZOTUS, Azoth, or Ashdod, one of the five cities of the Philiſtines, and a celebrated ſea-port on the Mediterranean, ſituated about 14 or 15 miles ſouth of Ekron, between that and Aſcalon. It was in this city that the idol Dagon fell down before the ark: and ſo ſtrong a place it was, if we may believe Herodotus, that it ſuſtained a ſiege of 29 years by Pſammeticus king of Egypt. It was, however, taken by the Maccabees in a much ſhorter time; who burnt both city and temple, and with them about 1000 men. The town is now called by the Arabs *Aaſaneyun*. It is but thinly inhabited, though the ſituation is very pleaſant: with regard to the houſes, thoſe that were built in the time of Chriſtianity, and which are now inhabited by Mahometans, ſtill preſerve ſome claim to admiration; but the modern buildings, though generally of ſtone, have nothing in them which can attract the notice of a traveller. The ſtreets are pretty broad, the inhabitants moſtly Mahometans, with a few Chriſtians of the Greek communion, who have a church under the juriſdiction of the archbiſhop of Gaza. The town is about a mile and a half in circumference; and has in it a moſque, a public bath, a market-place, and two inns. The number of the inhabitants is between two and three thouſand. The moſt remarkable things in this place is an old ſtructure with fine marble pillars, which the inhabitants ſay was the houſe that Sampſon pulled down; and to the ſouth-eaſt, juſt out of the town, the water in which the eunuch Candace was baptized by the apoſtle Philip: beſides theſe two, there are ſeveral ancient buildings, with capitals and pillars ſtanding.

AZURE, in a general ſenſe, the blue colour of the ſky. See Sky and Blue.

Azure, among *Painters*. This word, which at preſent ſignifies in general a fine blue colour, was formerly applied to *lapis lazuli*, called *azure ſtone*, and to the blue prepared from it. But ſince a blue has been extracted from cobalt, cuſtom has applied to it the name of *azure*, although it differs conſiderably from the former, and is incapable of being uſed for the ſame purpoſes, and particularly for painting in oil. The former at preſent is called *lapis lazuli*, or only *lapis*; and the blue prepared from it for painting in oil, is called *ultramarine*.—The name *azure* is generally applied to the blue glaſs made from the earth of cobalt and vitriſiable matters. This glaſs, which is called *ſmalt* when in maſſes, is called *azure* only when it is reduced to a fine powder. Several kinds of azure are diſtinguiſhed, according to its degrees of beauty, by the names of *fine azure*, *powdered azure*, and *azure of four fires*. In general, the more intenſe the colour, and the finer the powder, the more beautiful and dear it is. Azure is employed to colour ſtarch; hence it has alſo been called *ſtarch blue*. It is uſed for painting with colours, and for a blue enamel.

Azure, in *Heraldry*, the blue colour in the arms of any perſon below the rank of a baron. In the eſcutcheon of a nobleman, it is called *ſapphire*; and in that of a ſovereign prince, *Jupiter*. In engraving, this colour is expreſſed by lines or ſtrokes drawn horizontally.—This colour may ſignify Juſtice, Perſeverance, and Vigilance; but according to G. Leigh, when compounded with

Or	it ſignifies	Cheerfulneſs.
Arg.		Vigilance.
Gul.		Readineſs.
Ver.		Enterpriſe.
Pur.		Goodneſs.
Sab.		Mournfulneſs.

French heralds, *M. Upton*, and his followers, rank this colour before gules.

AZYGOS, in *Anatomy*, a vein riſing within the thorax, on the right ſide, having no fellow on the left; whence it is called *azygos*, or *vena ſine pari*.

AZYMITES, in *Church Hiſtory*, Chriſtians who adminiſter the euchariſt with unleavened bread. The word is formed from the Greek α priv. and ζυμη, *ferment*.—This appellation is given to the Latin by the Greek church, becauſe the members of the former uſe fermented bread in the celebration of the euchariſt. They alſo call the Armenians and Maronites by the ſame name, and for the ſame reaſon.

AZYMOUS, ſomething unfermented, or made without leaven; as unleavened bread. Sea biſcuit is of this kind; and therefore, according to Galen, leſs wholeſome than bread that has been fermented.

B.

B, THE ſecond letter of the Engliſh and moſt other alphabets. It is the firſt conſonant, and firſt mute, and its pronunciation is ſuppoſed to reſemble the bleating of a ſheep; upon which account Pierius tells us in his hieroglyphics, that the Egyptians repreſented the ſound of this letter by the figure of that animal.

B is alſo one of thoſe letters which the eaſtern grammarians call *labial*, becauſe the principal organs employed in its pronunciation are the lips. It is pronounced

Baal.

ced by pressing the whole length of them together, and forcing them open with a strong breath. It has a near affinity with the other labials P and V, and is often used for P both by the Armenians and other orientals, as in *Betrus* for *Petrus*, *apsens* for *absens*, &c.; and by the Romans for V, as in *amabit* for *amavit*, *berna* for *verna*, &c. whence arose that jest of Aurelian on the emperor Bonosus, *Non ut vivat natus est, sed ut bibat.*

Plutarch observes, that the Macedonians changed φ into B, and pronounced *Bilip*, *Berenice*, &c. for *Philip*, *Pherenice*, &c.; and those of Delphos used B instead of Π, βαθειν for παθειν, βικρον for πικρον, &c.—The Latins said *suppono*, *oppono*, for *subpono*, *obpono*; and pronounced *optinuit*, though they wrote *obtinuit*, as Quintilian has observed.—They also used B for F or PH: thus, in an ancient inscription mentioned by Gruter, OBRENDARIO, is used for OFRENDARIO.

As a numeral B was used by the Greeks and Hebrews to denote 2; but among the Romans for 300, and with a dash over it (thus $\bar{B}$) for 3000.

B is also used as an abbreviation. Thus B.A. stands for bachelor of arts; B. L. for bachelor of laws; and B. D. for bachelor of divinity. B. F. in the preface to the decrees or senatus consulta of the old Romans signified *bonum factum*. In music, B stands for the tone above A; as B^b, or ^bB, does for B flat, or the semitone major above A. B also stands for bass; and B. C. for *basso continuo*, or thorough bass.

BAAL, the same as BEL, or BELUS; an idol of the Chaldeans, and Phœnicians or Canaanites. The former worshipped Mars under this name, according to Josephus*; who, speaking of Thurus the successor of Ninus, says, "To this Mars the Assyrians erected the first statue, and worshipped him as a god, calling him *Baal*." It is probable the Phœnicians worshipped the sun under the name of Baal; for Josiah, willing to make some amends for the wickedness of Manasseh, in worshipping Baal, and all the host of heaven, *put to death the idolatrous priests that burnt incense unto Baal, to the sun, and to the moon, and to the planets, and to all the host of heaven. He likewise took away the horses that the kings of Judah had given to the sun, and burnt the chariots of the sun with fire* †.

* *Antiquit.* lib. viii. cap. 7.

† 2 Kings xxiii. 5. 11.

The temples consecrated to this god, are called in the Scripture *Chamanim*, which signifies *places enclosed with walls* in which was kept a perpetual fire. Maundrell, in his journey from Aleppo to Jerusalem, observed some traces of these enclosures in Syria. In most of them were no statues; in a few there were some, but of no uniform figure.

The word *baal* (in the Punic language), signifies *lord* or *master*; and doubtless meant the supreme Deity, the Lord and Master of the universe. It is often joined with the name of some false god, as *Baal-berith*, *Baal-peor*, *Baal-zephon*, and the like. This deity passed from the Phœnicians to the Carthaginians, who were a colony of the Phœnicians; as appears from the Carthaginian names, Hannibal, Asdrubal, &c. according to the custom of the east, where kings and great men added to their own names those of their gods.

This false deity is frequently mentioned in Scripture in the plural number (*Baalim*); which may signify, either that the name *Baal* was given to several different gods; or that there were many statues, bearing different appellations, consecrated to this idol. Arnobius tells us, that Baal was of an uncertain sex; and that his votaries, when they called upon him, invoked him thus: *Hear us, whether thou art a god or a goddess.*

Baal-berith ‖ Babel.

Some learned men think, that the Baal of the Phœnicians is the Saturn of the Greeks; which is probable enough from the conformity there is between the human sacrifices offered to Saturn and those which the Scripture tells us were offered to Baal. Others are of opinion, that Baal was the Phœnician or Tyrian Hercules, a god of great antiquity in Phœnicia.

BAAL BERITH, the god of the Shechemites. Bochart conjectures, that Berith is the same as *Beroe*, the daughter of Venus and Adonis, who was given in marriage to Bacchus; and that she gave her name to the city of Berith in Phœnicia, and became afterwards the goddess of it. Baal-berith signifies *Lord of the covenant*, and may be taken for the god who presides over alliances and oaths, in like manner as the Greeks had their Ζευς ορκιος, and the Romans their *Deus Fidius*, or *Jupiter Pistius*. The idolatrous Israelites, we are told, *made Baal-berith their god*, Judg. viii. 33.

BAAL-PEOR, *Baal-phegor*, or *Beel-phegor*, an idol of the Moabites and Midianites. We are told, that *Israel joined himself to Baal-peor*; and that Solomon erected an altar to this idol upon the mount of Olives. Baal-peor has been supposed to be no other than a Priapus, and that the worship of him consisted in the most obscene practices. Others have thought, that as Baal is a general name signifying *Lord*, Peor may be the name of some great prince deified after his death. Mede imagines, that *Peor* being the name of a mountain in the country of Moab, on which the temple of Baal was built, Baal-peor may be only another name of that deity, taken from the situation of his temple; in like manner as Jupiter is styled *Olympius*, because he was worshipped in a temple built on Mount Olympus. Selden, who is of this latter opinion, conjectures likewise, that Baal-peor is the same with Pluto; which he grounds upon these words of the Psalmist *, *They joined themselves unto Baal-peor, and ate the offerings of the dead*; though by the *sacrifices* or *offerings of the dead*, in this passage, may be meant no more than sacrifices or offerings made to idols, or false gods, who are very properly called *the dead*, in contradistinction to the true God, who is styled in Scripture the *living God.*

* Psalm cvi.

BAAL-ZEBUB, *Beel-zebub*, or *Belzebub*; the idol, or god, of the Ekronites. In Scripture he is called the *Prince of Devils*. His name is rendered the *Lord of Flies*, or the *God-fly*; which some think was a mock appellation bestowed on him by the Jews. He had a famous temple and oracle at Ekron. Ahaziah king of Israel, having fallen from the terrace of his house into a lower room, and being dangerously hurt, sent to consult this deity, to know if he should be cured of his wounds. The worship of this false god must have prevailed in our Saviour's time, since the Jews accused him of driving out devils in the name of *Belzebub* their prince. Scaliger derives the name of this deity from *Baalim-zebahim*, which signifies the *Lord of sacrifices.*

BABBLING, among *Hunters*, is when the hounds are too busy after they have found a good scent.

BABEL, a city and tower undertaken to be built by

Babel.

by the whole human race ſoon after the flood, and remarkable for the miraculous fruſtration of the attempt by the confuſion of languages. As to the ſituation of ancient Babel, moſt authors are of opinion that it was exactly in the place where the celebrated city of Babylon afterwards ſtood. That it was in the ſame country, appears indiſputably from Scripture; but that it was exactly in the ſame place is what cannot be proved, nor is it a matter of any conſequence.

Authors have been much divided about the motive by which the whole race of mankind were induced to join as one man in ſuch an undertaking. Some have imagined that it was out of fear of a ſecond deluge; others, that they knew beforehand that they were to be diſperſed through all the different countries of the world, and built this tower in order to defeat the deſign of the Deity, becauſe having a tower of ſuch vaſt height as they propoſed, thoſe who were at a diſtance could eaſily find their way back again. Had either of theſe been their deſign, however, it is probable they would have choſen an eminence rather than a plain for the ſituation of their tower, or indeed that they would have choſen ſome high mountain, ſuch as Ararat, for their mark, rather than any tower at all: for though it is ſaid that they deſigned the top of their tower to reach to heaven, we can ſcarce ſuppoſe them to have been ſo abſurd, as to imagine this poſſible in the ſenſe we underſtand it; and muſt therefore rather take it in the limited ſenſe in which it is often uſed by Moſes and his countrymen, where they ſpeak of cities walled up to heaven. Others there are who imagine that the top of this tower was not to reach up to heaven, but to be conſecrated to the heavens, *i. e.* to the worſhip of the ſun, moon and ſtars; of the fire, air, &c. and other natural powers, as deities; and therefore that the true Deity interpoſed in order to prevent a total and irrecoverable defection. Certain it is, that the ſpecies of idolatry which takes for the objects of its worſhip thoſe natural agents, as it is the moſt ancient, ſo it is by far the moſt rational, and the moſt difficult to be diſproved. It is much more difficult, for inſtance, to prove that the ſun, which by his enlivening beams gives vigour to the whole creation, is not a deity, than that a log of wood is not one: and hence if ſuch a ſyſtem of religion became univerſally eſtabliſhed among mankind, it would be impoſſible ever afterwards to eradicate it. Indeed that the ſcheme of Babel, whatever it was, could have been put into execution by man, ſeems evident from the interpoſition of the Deity on the occaſion; for we cannot ſuppoſe that he would have worked a miracle on purpoſe to defeat that which would have defeated itſelf if he had let it alone: and he expreſsly ſays, That now nothing could be reſtrained from them; which intimates very plainly, that, had this ſcheme gone on, the plan which God had laid for the government of the world would have been totally fruſtrated: and agreeable to this hypotheſis Dr Teniſon ſuppoſes that the tower was of a pyramidal form, in imitation of the ſpires of flame; and that it was erected in honour of the ſun, as being the moſt probable cauſe of drying up the flood.

As to the materials made uſe of in the building of this tower, the Scripture informs us that they were bricks and ſlime or bitumen. According to an eaſtern tradition, three years were taken up in making the bricks, each of which was 13 cubits long, 10 broad, and five thick. Oriental writers ſay, that the city was 313 fathoms in length, and 151 in breadth; that the walls were 5533 fathoms high, and 33 in breadth; and that the tower itſelf was no leſs than 10,000 fathoms, or 12 miles high. Even St Jerome affirms from the teſtimony of eye-witneſſes, who as he ſays had examined the remains of the tower, that it was four miles high; but Ado makes the height to have been no leſs than 5000 miles. The only account of its dimenſions which can be at all depended upon (ſuppoſing it to have been the ſame which afterwards ſtood in the midſt of the city of Babylon, and round which Nebuchadnezzar built the temple of Belus), is that given under the article Babylon.

Babel mandel || ...ton.

BABEL MANDEL, the gate of mourning; a famous ſtrait in the Indian ocean, between the coaſt of Arabia Felix in Aſia, and that of Adel and Zeila in Africa, at the entrance into the Red ſea. By ſome it is alſo called the *Straits of Moka*. It is narrow, and difficult to ſail through, on account of the ſand banks. At the mouth of the ſtrait is a ſmall iſland called alſo *Babel Mandel*, which is little elſe than a barren rock. E. Long. 44. 30. N. Lat. 12. 40.

BABENHAUSEN, a town of Germany in Suabia. E. Long. 9. 16. N. Lat. 48. 39.

BABINA, Commonwealth of, a ſociety ludicrouſly ſo called, which was founded in Poland in the reign of Sigiſmund Auguſtus, in the 16th century. It took its riſe from a ſet of gentlemen, inhabitants of Lublin, who had agreed to meet at a place called *Babina*, merely for the purpoſes of mirth and jollity. In time their number increaſed, and they formed themſelves into a regular government, under the preſidency of a king, ſenate, and chief magiſtrate. The magiſtrates were elected from ſomething which appeared ridiculous in the character or conduct of any of the members. For inſtance, if any perſon was meddling or officious, he was immediately created an archbiſhop; a blundering or diſputatious member was promoted to the ſpeaker's chair; a boaſter of his own courage, and vain-glorious *Thraſo*, was honoured with the commiſſion of generaliſſimo, which was preſented him with great ceremony by the ſubordinate heroes. Thoſe who declined the office for which they were declared qualified were perſecuted with hiſſings, and abandoned by the ſociety. Thus every vice and every foible was attacked with ridicule; and Babina became in a ſhort time the terror, the admiration, and the reformer, of the Poliſh nation: genius flouriſhed, wit was cultivated, and the abuſes which had crept into government and ſociety were corrected by the judicious application of good humoured ſatire. Never did any inſtitution of this nature become ſo general or ſo uſeful; but at length it degenerated into a ſet of buffoons, and banterers of every thing ſacred or profane. For ſeveral years it was patronized by the kings of Poland, and Sigiſmund himſelf became a member; the ſtaroſta of Babina telling him jocularly, that "his majeſty had certain qualities which entitled him to the firſt dignity in the commonwealth". Not the leaſt remnant of the ſociety now remains, though it was honoured with extraordinary privileges by kings and emperors.

BABINGTON, Gervase, biſhop of Worceſter, was

was born, according to Fuller, in Nottinghamſhire; but in what year is uncertain. He was ſent to Trinity College, Cambridge, of which he was made fellow; and, in 1578, was incorporated maſter of arts at Oxford. He appears, however, to have made Cambridge the place of his reſidence, where he became an eminent preacher; and, being now doctor in divinity, was made domeſtic chaplain to Henry earl of Pembroke. In this ſtation he is ſuppoſed to have aſſiſted the counteſs in her tranſlation of the Pſalms. In 1588 he was inſtalled prebend of Hereford, and in 1591 conſecrated biſhop of Landaff. In 1564 he was tranſlated to the ſee of Exeter, and thence to Worceſter in 1597. About this time, or ſoon after, he was made queen's counſel for the marſhes of Wales. He was a conſiderable benefactor to the library belonging to the cathedral of Worceſter, where he was buried in May 1610 without a monument. The ſeveral hiſtorians who have mentioned this prelate agree in giving him the character of a learned and pious man. His writings, like thoſe of moſt of his cotemporaries, abound with puns and quaint expreſſions. His works were printed both in folio and quarto in 1615, and again in folio in 1637, under this title: *The works of the right reverend father in God Gervaſe Babington, late biſhop of Worceſter, containing comfortable notes upon the five books of Moſes, viz. Geneſis, &c. As alſo an expoſition upon the Creed, the Ten Commandments, the Lord's Prayer; with a conference betwixt man's frailtie and faith, and three ſermons, &c.*

BABOON, in *Zoology*. See SIMIA, MAMMALIA *Index*.

BABYLON, the capital of the ancient kingdom of Babylonia or Chaldea, and ſuppoſed to have ſtood in E. Long. 44. 0. N. Lat. 32. 0. Semiramis is ſaid by ſome, and Belus by others, to have founded this city. But, by whomſoever it was founded, Nebuchadnezzar was the perſon who put the laſt hand to it, and made it one of the wonders of the world. The moſt famous works in and about it were the walls of the city, the temple of Belus, Nebuchadnezzar's palace, the hanging-gardens, the banks of the river, the artificial lake, and canals.

1 City deſcribed.

The city was ſurrounded with walls, in thickneſs 87 feet, in height 350 feet, and in compaſs 480 furlongs or 60 of our miles. Thus Herodotus, who was himſelf at Babylon; and though ſome diſagree with him in theſe dimenſions, yet moſt writers give us the ſame, or nearly the ſame, as he does. Diodorus Siculus diminiſhes the circumference of theſe walls very conſiderably, and takes ſomewhat from the height of them, as in Herodotus; though he ſeems to add to their breadth by ſaying, that ſix chariots might drive abreaſt thereon: while the former writes, that one chariot only might turn upon them; but then he places buildings on each ſide of the top of theſe walls, which, according to him, were but one ſtory high; which may pretty well reconcile them together in this reſpect. It is obſerved, that thoſe who give the height of theſe walls but at 50 cubits, ſpeak of them only as they were after the time of Darius Hyſtaſpis, who had cauſed them to be beaten down to that level. Theſe walls formed an exact ſquare, each ſide of which was 120 furlongs, or 15 miles, in length; and were all built of large bricks cemented together with bitumen, which in a ſhort time grows harder than the very brick and ſtone which it cements. The city was encompaſſed, without the walls, with a vaſt ditch filled with water, and lined with bricks on both ſides; and, as the earth that was dug out of it ſerved to make the bricks, we may judge of the depth and largeneſs of the ditch from the height and thickneſs of the walls. In the whole compaſs of the wall there were 100 gates, that is, 25 on each of the four ſides, all made of ſolid braſs. Between every two of theſe gates, at proper diſtances, were three towers, and four more at the four corners of this great ſquare, and three between each of theſe corners and the next gate on either ſide, and each of theſe towers was ten feet higher than the walls. But this is to be underſtood only of thoſe parts of the walls where towers were needful for defence. For ſome parts of them being upon a moraſs, and inacceſſible by an enemy, there the labour and coſt was ſpared, which, though it muſt have ſpoiled the ſymmetry of the whole, muſt be allowed to have ſavoured of good œconomy; though that is what one would not have expected from a prince who had been ſo determined, as Nebuchadnezzar muſt have been, to make the city complete both for ſtrength and beauty. The whole number, then, of theſe towers amounted to no more than 250; whereas a much greater number would have been neceſſary to have made the uniformity complete all round. From each of the 25 gates on each ſide of this ſquare, there was a ſtraight ſtreet, extending to the correſponding gate in the oppoſite wall; whence the whole number of the ſtreets muſt have been but 50; but then they were each about 15 miles long, 25 of them croſſing the other 25 exactly at right angles. Beſides theſe whole ſtreets, we muſt reckon four half ſtreets, which were but rows of houſes facing the four inner ſides of the walls. Theſe four half ſtreets were properly the four ſides of the city within the walls, and were each of them 200 feet broad, the whole ſtreets being about 150 of the ſame. By this interſection of the 50 ſtreets, the city was divided into 676 ſquares, each of four furlongs and a half on each ſide, or two miles and a quarter in compaſs. Round theſe ſquares, on every ſide towards the ſtreets, ſtood the houſes, all of three or four ſtories in height, and beautified with all manner of ornaments; and the ſpace within each of theſe ſquares was all void, and taken up by yards, or gardens, and the like, either for pleaſure or convenience.

A branch of the Euphrates divided the city into two, running through the midſt of it, from north to ſouth; over which, in the very middle of the city, was a bridge, a furlong in length, or rather more; and indeed much more, if we hearken to others, who ſay it was no leſs than five ſtades or furlongs in length, though but 30 feet broad, a difference we ſhall never be able to decide. This bridge, however, is ſaid to have been built with wonderful art, to ſupply a defect in the bottom of the river, which was all ſandy. At each end of this bridge were two palaces: the old palace on the eaſt ſide, the new one on the weſt ſide of the river; the former of which took up four of the ſquares abovementioned, and the latter nine. The temple of Belus, which ſtood next to the old palace, took up another of the ſame ſquares.

The whole city ſtood in a large flat or plain, in a very fat and deep ſoil: that part or half of it on the eaſt

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east side of the river was the old city, and the other on the west was added by Nebuchadnezzar, both being included within the vast square bounded by the walls aforesaid. The form of the whole was seemingly borrowed from Nineveh, which was also 480 furlongs; but though it was equal in dimensions to this city, it was less with respect to its form, which was a parallelogram, whereas that of Babylon was an exact square. It is supposed, that Nebuchadnezzar, who had destroyed that old seat of the Assyrian empire, proposed that this new one should rather exceed it; and that it was in order to fill it with inhabitants, that he transported such numbers of the captives from other countries hither; though that is what may be disputed, seeing he therein only followed the constant practice of the kings of Assyria, who thought this the most certain means of ensuring their conquests either to themselves or their posterity.

2 Was never fully peopled.

But it plainly appears, that it was never wholly inhabited; so that, even in the meridian of its glory, it may be compared with the flower of the field, which flourishes to-day, and to-morrow is no more. It never had time to grow up to what Nebuchadnezzar visibly intended to have made it; for, Cyrus removing the seat of the empire soon after to Shushan, Babylon fell by degrees to utter decay: yet it must be owned, that no country was better able to support so vast and populous a city, had it been completed up to its first design. But so far was it from being finished according to its original design, that, when Alexander came to Babylon, Q. Curtius tells us, "No more than 90 furlongs of it were then built:" which can be no otherwise understood than of so much in length; and, if we allow the breadth to be as much as the length (which is the utmost that can be allowed), it will follow, that no more than 8100 square furlongs were then built upon: but the whole space within the walls contained 14,400 square furlongs; and therefore there must have been 6300 square furlongs remaining unbuilt, which, Curtius tells us, were ploughed and sown. And, besides this, the houses were not contiguous, but all built with a void space on each side, between house and house.

3 Temple of Belus.

The next great work of Nebuchadnezzar was the temple of Belus. The wonderful tower, however, that stood in the middle of it, was not his work, but was built many ages before; that, and the famous tower of Babel, being, as is commonly supposed, one and the same structure. This tower is said to have been composed of eight pyramidal ones raised above one another, and by Herodotus said to have been a furlong in height; but as there is an ambiguity in his expression, it has been disputed whether each of the towers was a furlong in height, or the whole of them taken together. On the latter supposition, which is the most probable, this tower must have exceeded the highest of the Egyptian pyramids by 179 feet, though it fell short of its breadth at the basis by 33. The way to go up was by stairs on the outside round it; whence it seems most likely, that the whole ascent was, by the benching in, drawn in a sloping line from the bottom to the top eight times round it; and that this made the appearance of eight towers, one above the other. Till the times of Nebuchadnezzar, it is thought this tower was all the temple of Belus; but as he did by the other ancient buildings of the city, so he did by this, making great additions thereto, by vast edifices erected round it, in a square of two furlongs on every side, and just a mile in circumference, which exceeded the square at the temple of Jerusalem by 1800 feet. On the outside of these buildings was a wall, which enclosed the whole; and, in consideration of the regularity wherewith this city was to all appearance marked out, it is supposed, that this wall was equal to the square of the city wherein it stood, and so is concluded to have been two miles and a half in circumference. In this wall were several gates leading into the temple, and all of solid brass; which it is thought may have been made out of the brazen sea, and brazen pillars, and other vessels and ornaments of the kind, which Nebuchadnezzar had transported from Jerusalem; for in this temple he is said to have dedicated his spoils from that of Jerusalem.

4 Idols of gold, &c.

In this temple were several images or idols of massy gold, and one of them, as we have seen, 40 feet in height; the same, as supposed, with that which Nebuchadnezzar consecrated in the plains of Dura. For though this last is said to have been 60 cubits, or 90 feet high, these dimensions appear so incredible, that it has been attempted to reconcile them into one, by supposing, that in the 90 feet the height of the pedestal is included, and that the 40 feet are for the height of the statue without the pedestal; and being said to have weighed 1000 talents of Babylon, it is thence computed, that it was worth three milions and a half of our money. In a word, the whole weight of the statues and decorations, in Diodorus Siculus, amounting to 5000 and odd talents in gold, the whole is estimated at above 21,000,000l. of our money; and a sum about equal to the same, in treasure, utensils, and ornaments, not mentioned, is allowed for.

Next to this temple, on the east side of the river, stood the old palace of the kings of Babylon, being four miles in circumference. Exactly opposite to it, on the other side of the river, was the new palace built by Nebuchadnezzar, eight miles in circumference, and consequently four times as big as the old one.

5 Hanging gardens.

But nothing was more wonderful at Babylon than the hanging-gardens, which Nebuchadnezzar made in complaisance to his wife Amyte; who, being a Mede, and retaining a strong inclination for the mountains and forests of her own country, was desirous of having something like them at Babylon. They are said to have contained a square of four plethra, or 400 feet, on each side; and to have consisted of terraces one above another, carried up to the height of the wall of the city, the ascent from terrace to terrace being by steps ten feet wide. The whole pile consisted of substantial arches upon arches, and was strengthened by a wall surrounding it on every side, 22 feet thick; and the floors on each of them were laid in this order; first, on the tops of the arches was laid a bed or pavement of stones 16 feet long, and four feet broad; over this was a layer of reed mixed with a great quantity of bitumen; and over this two courses of brick, closely cemented together with plaster; and over all these were thick sheets of lead, and on these the earth or mould of the garden. This floorage was designed to retain the moisture of the mould; which was so deep, as to give root to the greatest trees which were planted up-

Babylon.

on every terrace, together with great variety of other vegetables pleaſing to the eye. Upon the uppermoſt of theſe terraces was a reſervoir, ſupplied by a certain engine with water from the river, from whence the gardens on the other terraces were ſupplied.

6
Banks of the river, canals, &c.

The other works attributed to Nebuchadnezzer by Beroſus and Abydenus, were the banks of the river, the artificial canals, and the great artificial lake ſaid to have been ſunk by Semiramis. The canals were cut out on the eaſt ſide of the Euphrates, to convey the water of the river, when it overflowed its banks, into the Tigris, before they reached Babylon. The lake was on the weſt ſide of Babylon; and, according to the loweſt computation, 40 miles ſquare, 160 in compaſs, and in depth 35 feet, as we read in Herodotus, or 75, as Megaſthenes will have it; the former, perhaps, meaſured from the ſurface of the ſides, and the latter from the tops of the banks that were caſt up upon them. This lake was dug to receive the waters of the river, while the banks were building on each ſide of it. But both the lake, and the canal which led to it, were preſerved after that work was completed, being found of great uſe, not only to prevent all overflowings, but to keep water all the year, as in a common reſervoir, to be let out, on proper occaſions, by ſluices, for the improvement of the land.

The banks were built of brick and bitumen, on both ſides of the river, to keep it within its channel; and extended on each ſide throughout the whole length of the city, and even farther, according to ſome, who reckon they extended 160 furlongs, or twenty miles; whence it is concluded they muſt have begun two miles and a half above the city, and have been continued an equal diſtance below it, the length of the city being no more than 15 miles. Within the city they were built from the bottom of the river, and of the ſame thickneſs with the walls of the city itſelf. Oppoſite to each ſtreet, on either ſide of the river, was a brazen gate in the ſaid wall, with ſtairs leading down from it to the river: theſe gates were open by day, and ſhut by night.

Beroſus, Megaſthenes, and Abydenus, attribute all theſe works to Nebuchadnezzar; but Herodotus tells us, the bridge, the banks, and the lake, were the work of a queen after him, called *Nitocris*, who may have finiſhed what Nebuchadnezzar left imperfect, and thence have had the honour this hiſtorian gives her of the whole.

The tower or temple ſtood till the time of Xerxes. But that prince, on his return from the Grecian expedition, having firſt plundered it of its immenſe wealth, demoliſhed the whole, and laid it in ruins. Alexander, on his return to Babylon from his Indian expedition, propoſed to rebuild it, and accordingly ſet 10,000 men to work to clear away the rubbiſh. But his death happening ſoon after, a ſtop was put to all further proceedings in that deſign. After the death of that conqueror, the city of Babylon began to decline apace; which was chiefly owing to the neighbourhood of Seleucia, built by Zeleucus Nicator, as is ſaid, out of ſpite to the Babylonians, and peopled with 500,000 perſons drawn from Babylon, which by that means continued declining till the very people of the country were at a loſs to tell where it had ſtood.

Such is the deſcription we have by ancient hiſtorians of the grandeur of this city; which, if theſe accounts are not exaggerated, muſt have exceeded every piece of human grandeur that hath yet appeared. Many of the moderns, however, are of opinion that theſe magnificent deſcriptions are very far from being true; although it is certain that few other arguments can be brought againſt the reality of them, than that we do not ſee things of a ſimilar kind executed in our own days. The following are the arguments uſed on this ſubject by the preſent Goguet.

"Authors have greatly extolled the public works and edifices which once rendered Babylon one of the wonders of the world. We may reduce all theſe objects to five principal heads: 1. the height of its walls; 2. the temple of Belus; 3. the hanging gardens; 4. the bridge built over the river Euphrates, and the quays which lined the river; 5. the lake and canals dug by the hand of man to diſtribute the waters of the Euphrates.

7
Goguet's arguments againſt the truth of the foregoing relation.

"All theſe works, ſo marvellous in the judgment of antiquity, appear to me to have been extremely exaggerated by the authors who have ſpoke of them. How can we conceive, in effect, that the walls of Babylon could have been 318 feet high, and 81 in thickneſs, in a compaſs of near ten leagues?

"I ſhall ſay the ſame of that ſquare building, known under the name of *the temple of Belus*. It was com. poſed of eight towers placed one above another, diminiſhing always as they went up. Herodotus does not tell us what was the height of this monument. Diodorus ſays, that it ſurpaſſed all belief. Strabo fixes it to one ſtadium, a meaſure which anſwers nearly to 600 of our feet. For in the time of this geographer the ſtadia were much more conſiderable than in the firſt ages. The entire maſs of this building ought to have been anſwerable to its exceſſive height; and this is alſo the idea that the ancients deſigned to give us of it. We may judge by the following fact. Xerxes had entirely demoliſhed this temple. Alexander undertook to rebuild it. He deſigned to begin by clearing the place and removing the ruins. Ten thouſand workmen who were employed two months in this work, were not, ſay they, able to finiſh it.

"The riches encloſed in the temple of Belus were proportioned to its immenſity. Without ſpeaking of the tables and cenſers, the cups and other ſacred vaſes, of maſſy gold, there was a ſtatue 40 feet high, which alone weighed 1000 Babyloniſh talents. In ſhort, according to the inventory that the ancients have given us of the riches contained in this temple, the total ſum would amount to two hundred and twenty millions and a half of French livres. Exaggerations like theſe deſtroy themſelves.

"As to the hanging gardens, according to all appearance they never exiſted. The ſilence of Herodotus on a work ſo ſingular and ſo remarkable, determines one to place in the rank of fables all that the other writers have delivered upon this pretended wonder. Herodotus had carefully viſited Babylon. He enters into ſuch details as prove that he has omitted none of the rarities of that city. Can we preſume that he would have paſſed over in ſilence ſuch a work as the hanging gardens? All the authors who have ſpoken of it are of much later date than this great hiſtorian. None of them except Beroſus ſpeaks on his own teſtimony.

mony. It is always on the report of others. Diodorus had extracted from Ctesias what he says of these famous gardens. There is also great appearance that Strabo had drawn from the same source. In a word, the manner in which Quintius Curtius expresses himself, sufficiently shows how much the existence of these gardens appeared to him suspicious. He judged they owed the greatest part of it to the imagination of the Greeks.

"Let us now speak of the bridge of Babylon, which the ancients have placed in the number of the most marvellous works of the east. It was near 100 fathoms in length, and almost four in breadth. We cannot deny but that a great deal of art and labour was necessary to lay the foundations, which it could not be easy to settle in the bed of an extremely deep and rapid river, which also rolls along a prodigious quantity of mud, and whose botttom is entirely sandy. They had therefore taken many precautions to secure the piers of the bridge of Babylon. They were built of stones joined and fastened together with cramps of iron, and their joints filled with melted lead. The front of the piers, turned towards the current of the Euphrates, was defended by buttresses extremely advanced, which diminished the weight and force of the water, by cutting it at a great distance. Such was the bridge of Babylon.

"While we do justice to the skill of the Babylonians in conducting these works, we cannot help remarking the bad taste which at all times reigned in the works of the eastern nations. The bridge of Babylon furnishes a striking instance of it. This edifice was absolutely without grace, or any air of majesty. The breadth of it was in no sort of proportion to its length. The distance between the piers was also very ill contrived. They were distant from each other only 11 feet and a half. Finally, this bridge was not arched. We may judge of its effect on the view.

"The Babylonians, however, were not the only people who were ignorant of the art of turning an arch. This secret, as far as I can find, was unknown to all the people of remote antiquity, who, generally speaking, do not appear to have been very skilful in stone-cutting.

"As for the quays which lined the Euphrates, we may believe that they were grand and magnificent; but I shall not easily believe that they surpassed those which we have daily under our eye. In this respect, I believe Paris may dispute it for magnificence, and for the extent of the work, with all the cities of the universe."

Babylon, a town of Egypt near the eastmost branch of the river Nile, now supposed to be *Grand Cairo*, or this city to stand near its ruins. E. Long. 31. 12. N. Lat. 30. 5.

BABYLONIA, or Chaldea, a kingdom of Asia, and the most ancient in the world, being founded by Nimrod the grandson of Ham, who also, according to the margin of our Bibles, founded Nineveh the capital of the kingdom of Assyria. Indeed, these two kingdoms seem to have always continued in such a state of friendship, that we can scarce help thinking they must have been the same, or perhaps Babylonia was for some time a province of Assyria. Nothing certain is known concerning either of them, except what may be gathered from Scripture. From thence we learn, that in the days of Abraham there was a king of *Shinar*, called *Amraphel*, who, under the king of Elam or Persia, made war upon the Canaanites. From this time we have nothing that can be depended upon till the days of Nabonasser, the first king of Babylon mentioned in Ptolemy's canon. It is plain, indeed, both from Scripture and profane history, that Babylonia subsisted as a distinct kingdom from Assyria even when the latter was in all its glory. The most probable account of the matter is this: The empire of Assyria was founded by Pul, on the ruins of that of Damascus or Syria, in the days of Menahem king of Judah. This king left two sons, Tiglath-Pileser, and Nabonasser. To the former he bequeathed the empire of Assyria, and to the latter that of Babylon. Tiglath-Pileser resided at Nineveh, the original seat of the Assyrian empire; while Nabonasser, who was the younger brother, held his residence at Babylon. As the two kingdoms were governed by princes of the same family, we may well suppose a perfect harmony to have reigned between them, the younger branch at Babylon acknowledging a kind of subjection to the elder at Nineveh. That the Babylonian empire was of Assyrian origin, we are assured by the prophet Isaiah, in the following words: "Behold the land of the Chaldeans: this people was not till the Assyrian founded it for them that dwelt in the wilderness: they set up the towers thereof; they built the palace thereof." As to the kingdom of Assyria, the Scripture mentions only five kings, viz. Pul, Tiglath-Pileser, Shalmanaser, Sennacherib, and Esarhaddon; whose history, as related by the sacred writers, it is needless to mention particularly here. From the days of Nabonasser to Nabopolasser, that is, from the year before Christ 747 to 626, the kings of Babylon made no figure, and were therefore probably in a state of dependence on the kings of Assyria; but at that time, in the reign of *Chyniladan*, the Sardanapalus of the Greeks, Nineveh was taken and destroyed by the Medes and Babylonians, and the seat of the empire transferred to Babylon. This Nabopolasser was the father of the famous Nebuchadnezzar, for whose history we must refer to the sacred writers; and from his time to that of the *Belshazzar* of Daniel, and *Nabonadius* of other authors, the history of Babylon is little better than a mere blank. Of the reduction of Babylon by Cyrus, which happened at this time, we have the following account.

War had been begun betwixt the Medes, Persians, and Babylonians, in the reign of Neriglissar the father of Nabonadius, which had been carried on with very bad success on the side of the Babylonians. Cyrus, who commanded the Median and Persian army, having subdued the several nations inhabiting the great continent from the Ægean sea to the Euphrates, bent his march towards Babylon. Nabonadius, hearing of his march, immediately advanced against him with an army. In the engagement which ensued, the Babylonians were defeated; and the king, retreating to his metropolis, was blocked up and closely besieged by Cyrus. The reduction of this city was no easy enterprise. The walls were of a prodigious height, the number of men to defend them very great, and the place stored with all sorts of provisions for 20 years. Cyrus, despairing of being able to take such a city by storm, caused a line of circumvallation to be drawn quite round it, with a large and deep ditch; reckoning, that if all communication with the country were cut off, the besieged would be obliged to surrender through famine. That his troops might not be too much fatigued, he divided his army into twelve bodies, appointing each body its month to guard the trenches; but the besieged, looking upon themselves to be out of all danger by reason of their high walls and magazines, insulted him from the ramparts, and looked upon all the trouble he gave himself as so much unprofitable labour.

After Cyrus had spent two whole years before Babylon, without making any progress in the siege, he at last thought of the following stratagem, which put him in possession of it. He was informed, that a great annual solemnity was to be held at Babylon; and that the inhabitants on that occasion were accustomed to spend the whole night in drinking and debauchery. This he therefore thought a proper time for surprising them; and accordingly sent a strong detachment to the head of the canal leading to the great lake, with orders, at a certain time, to break down the great bank which was between the lake and the canal, and to turn the whole current into the lake. At the same time he appointed one body of troops at the place where the river entered the city, and another where it came out; ordering them to march in by the bed of the river as soon as they should find it fordable. Towards the evening he opened the head of the trenches on both sides the river above the city, that the water might discharge itself into them; by which means, and the breaking down of the great dam, the river was soon drained. Then the two above-mentioned bodies of troops, according to their orders, entered the channel; the one commanded by Gobryas and the other by Gadates: and finding the gates all left open by reason of the disorders of that riotous night, they penetrated into the very heart of the city without opposition; and meeting, according to agreement, at the palace, they surprised the guards, and cut them in pieces. Those who were in the palace opening the gates to know the cause of this confusion, the Persians rushed in, took the palace, and killed the king, who came out to meet them sword in hand. Thus an end was put to the Babylonian empire; and Cyrus took possession of Babylon for one called in Scripture *Darius the Mede*, most probably *Cyaxares II.* uncle to Cyrus. From this time Babylonia never was erected into a distinct kingdom, but hath always followed the fortune of those great conquerors who at different times have appeared in Asia. It is now frequently the object of contention between the Turks and Persians. See Assyria.

Concerning the nature of the country, manners, customs, &c. of the ancient Babylonians, the following account is collected by M. Sabbathier.

"As all the nations under the dominion of Cyrus, beside the ordinary tributes, were obliged to maintain him and his army, the monarch and his troops were supported by all Asia. The country of Babylon alone was obliged to maintain him four months of the year; its fertility, therefore, yielded a third of the produce of Asia. The government of this country, which the Persians termed *satrapy*, was richer and more extensive than any of the rest. It maintained for the king, besides the war-horses, a stud of 800 stallions, and 16,000 mares. So great a number of Indian dogs were likewise bred in this province for the king, that four of its cities kept those animals; and in return, they were exempted from all taxes and tributes.

"It rained very seldom in this country, according to Herodotus. The earth was watered by the river, which was here diffused by human industry, as the Nile is over Egypt by nature; for all the country of Babylon was divided by canals, the greatest of which was navigable, and flowed from south to north, from the Euphrates to the Tigris. In short, it was one of the finest countries for corn in the world; but for producing trees, the fig-tree, the vine, and the olive, it was not famous. It was so luxuriant in grain, that it commonly yielded a hundred times more than what was sown; and in good years it yielded three hundred times more than it received. The leaves of its wheat and barley were four inches broad. 'Though I know,' says Herodotus, 'that the millet and the sesame of that country grow to the size of trees, I will not describe them particularly; lest those who have not been in Babylonia should think my account fabulous.'

"They had no oil but what they made from Indian corn. The country abounded with palm-trees, which grew spontaneously; and most of them bore fruit, of which the inhabitants made bread, wine, and honey. They cultivated these trees and their fig-trees in the same manner. Some of them, as of other trees, the Greeks called *male* ones. They tied the fruit of the male to the trees which bore dates; that the mosquito, leaving the male, might cause the date to ripen, by penetrating it; for without that assistance it came not to maturity. Mosquitos bred in the male palms as in the wild fig-trees.

"But we must not here omit to give an account of the peculiar and surprising construction of their boats of skins, in which they sailed along the river to Babylon. These boats were invented by the Armenians, whose country lay north from Babylonia. They made them with poles of willow, which they bent, and covered with skins; the bare side of the skins they put outwards; and they made them so tight, that they resembled boards. The boats had neither prow nor stern, but were of a round form like a buckler. They put straw on the bottom. Two men, each with an oar, rowed them down the river, laden with different wares, but chiefly with palm wine. Of these boats some were very large, and some very small. The largest carried the weight of 500 talents. There was room for an ass in one of their small boats; they put many into a large one. When they had unloaded, after their arrival at Babylon, they sold the poles of their boats and the straw; and loading their asses with the skins, returned to Armenia: for they could not sail up the river, its current was so rapid. For this reason they made their boats of skins, instead of wood; and on their return to Armenia with their asses, they applied the skins to their former use.

"As to their dress, they wore a linen shirt, which came down to their feet. Over it they wore a woollen robe; their outer garment was a white vest. Their shoes resembled those of the Thebans. They let their hair grow. On their heads they wore a turban. They rubbed their bodies all over with fragrant liquors.

Each

Each man had a ring on his finger, and an elegant cane in his hand, with an apple at the top, or a rose, a lily, or an eagle, or some other figure; for they were not suffered to use canes without devices.

" With regard to their policy, Herodotus thinks that their best law was one which the Heneti, an Illyrian people, likewise observed in every town and village. When the girls were marriageable, they were ordered to meet in a certain place, where the young men likewise assembled. They were then sold by the public crier: but he first sold the most beautiful one. When he had sold her at an immense price, he put up others to sale, according to their degrees of beauty. The rich Babylonians were emulous to carry off the finest women, who were sold to the highest bidders. But as the young men who were poor could not aspire to have fine women, they were content to take the ugliest with the money which was given them: for when the crier had sold the handsomest, he ordered the ugliest of all the women to be brought; and asked, if any one was willing to take her with a small sum of money. Thus she became the wife of him who was most easily satisfied; and thus the finest women were sold; and from the money which they brought, small fortunes were given to the ugliest, and to those who had any bodily infirmity. A father could not marry his daughter as he pleased; nor was he who bought her allowed to take her home, without giving security that he would marry her. But, after the sale, if the parties were not agreeable to each other, the law enjoined that the purchase-money should be restored. The inhabitants of any of their towns were permitted to marry wives at these auctions. Such were the early customs of the Babylonians.

" But they afterwards made a law, which prohibited the inhabitants of different towns to intermarry, and by which husbands were punished for treating their wives ill. When they had become poor by the ruin of their metropolis, fathers used to prostitute their daughters for gain. There was a sensible custom among the Babylonians, worthy to be related. They brought their sick into the forum, to consult those who passed on their diseases; for they had no physicians. They asked those who approached the sick, if they ever had the same distemper? If they knew any one who had it? and how he was cured? Hence, in this country, every one who saw a sick person was obliged to go to him and inquire into his distemper.

" They embalmed their dead with honey; and their mourning was like that of the Egyptians.

" There were three Babylonian tribes, who lived only upon fish, and who prepared them in the following manner: they dried them in the sun, and then beat them in a mortar to a kind of flour, which after they had sifted through linen, they baked it in rolls.

" The Babylonians at first worshipped only the sun and the moon; but they soon multiplied their divinities. They deified Baal, Bel, or Belus, one of their kings, and Merodach-Baladan. They also worshipped Venus, under the name of *Mylitta*. She and Belus were the principal deities of the Babylonians. They counted their day from sunrise to sunrise. They solemnized five days of the year with great magnificence, and almost the same ceremonies with which the Romans celebrated their Saturnalia.

" The Babylonians were very much addicted to judicial astrology. Their priests who openly professed that art, were obliged to commit to writing all the events of the lives of their illustrious men; and on a fancied connection between those events and the motions of the heavenly bodies, the principles of their art were founded. They pretended that some of their books, in which their historical transactions and revolutions were accurately compared with the courses of the stars, were thousands of years old. This assertion of their judicial astrologers we may reasonably dispute; but that their astronomers had made a long series of observation, is incontestably true. It is certain that some of those observations were extant in the days of Aristotle, and that they were older than the empire of the Babylonians." See *History of* ASTRONOMY.

BABYLONIAN, BABYLONIUS, is used in some ancient writers for an astrologer, or any thing related to astrology. Hence *Babylonia cura*, the art of casting nativities; and *numeri Babylonii*, the computation of astrologers.

BABYLONICA TEXTA, a rich sort of weavings, or hangings, denominated from the city Babylon, where the practice of interweaving divers colours in their hangings first obtained. Hence also Babylonic garments, Babylonic skins, Babylonic carpets, housings, &c. *Babylonic solana*, coverings laid over couches, &c. painted with gold, purple, and other colours.

BABYLONICS, BABYLONICA, in *Natural History*, a fragment of the ancient history of the world, ending at 267 years before Christ; and composed by Berosus, or Berossus, a priest of Babylon, about the time of Alexander. Babylonics are sometimes also cited in ancient writers by the title of *Chaldaics*. The Babylonics were very consonant with Scripture, as Josephus and the ancient Christian chronologers assure; whence the author is usually supposed to have consulted the Jewish writers. Berosus speaks of an universal deluge, an ark, &c. He reckons ten generations between the first man and the deluge; and marks the duration of the several generations by *saroi*, or periods of 223 lunar months; which reduced to years, differ not much from the chronology of Moses.—The Babylonics consisted of three books, including the history of the ancient Babylonians, Medes, &c. But only a few imperfect extracts are now remaining of the work; preserved chiefly by Josephus and Syncellus, where all the passages of citations of ancient authors out of Berosus are collected with great exactness. Annius of Viterbo, to supply the loss, forged a complete Berosus out of his own head. The world has not thanked him for the imposture.

BABYROUSSA, in *Zoology*, a synonime of a species of sus. See SUS, MAMMALIA *Index*.

BAC, in *Navigation*, is used for a praam, or ferry-boat.

BAC, in *Brewing*, a large flat kind of tub, or vessel, wherein the wort is put to stand and cool before boiling. The ingredients of beer pass through three kinds of vessels. They are mashed in one, worked in another, and cooled in a third called *bacs* or *coolers*.

BAC, in *Distillery*, vessels into which the liquor to be fermented is pumped from the cooler, in order to be worked with yeſt.

Bac-Maker, is one who makes liquor-bacs, underbacs, coolers, maſh-tuns, working-tuns, &c. for the brewers. The workmanſhip is partly carpentry, in a particular manner, for it muſt be tight enough to hold liquor; and partly cooperage, *viz.* the maſh-tun, or vat, which is hooped. There are not many of this trade; and it requires chiefly ſtrength, with a little art. A ſmall ſtock of ſtuff, beſides tools, will ſet a man up tolerably well; but with 200l. or 300l. he will make a good figure in buſineſs.

BACA, or Baza, a town of Spain in the kingdom of Granada. W. Long. 3. 6. N. Lat. 37. 18. It is ſituated in a valley called *Hoya de Baza.* It is encompaſſed with old walls, and has a caſtle half ruined. It contains about 4000 houſes, but has nothing remarkable except the church dedicated to the Virgin Mary. The land about it is well cultivated for half a league round, and is fertile in wheat, wine, honey, hemp, and flax, being watered by the little river Guadalantin.

BACACUM, a town of the Nervii in Gallia Belgica; now *Bavay*, in Hainault. E. Long. 3. 30. N. Lat. 50. 25.

BACAIM, a handſome ſea-port town of the kingdom of Viſapour on the Malabar coaſt in Aſia. It is ſubject to the Portugueſe; and ſtands in E. Long. 73. 10. N. Lat. 19. 0.

BACASERAY, a town in the peninſula of Crim Tartary, and, as the khan uſually takes up his reſidence there, it may be conſidered as the capital of the country. E. Long. 35. 10. N. Lat. 45. 30.

BACANTIBI, in *Eccleſiaſtical Antiquity*, wandering clerks, who ſtrolled from church to church.—— The word ſeems formed by corruption from *vacantivi.*

BACCA, berry, in *Botany*, is uſed to ſignify ſuch fruits as conſiſt of a pericarpium full of juice and ſeeds, without any valves.

BACCALARIA, in middle-age writers, denotes a kind of country-farms, conſiſting of ſeveral manſes.

Baccalaria dominicaria, or *indominicata*, was more particularly uſed for a farm belonging to the lord, and kept in his own hands.

BACCARACH, a town of Germany in the Lower Palatinate; formerly imperial and free, but now ſubject to the elector Palatine. It is famous for excellent wine; and is ſituated on the Rhine, in E. Long. 7. 5. N. Lat. 49. 57.

BACCHÆ, in *Antiquity*, the prieſteſſes of Bacchus, who celebrated the *orgia* or myſteries of that god.— The word was alſo uſed for the ivy crowns or garlands worn by the prieſts of Bacchus, in offering ſacrifices to him.

BACCHANALIA, feaſts celebrated in honour of Bacchus by the ancients. The two moſt remarkable were called the *greater* and *leſſer*. The latter called *lenæa*, from a word ſignifying a *wine-preſs*, were held in the open fields about autumn; the greater, called *Dionyſia*, from one of the names of Bacchus, were celebrated in the city, about the ſpring-time. Both theſe feaſts were accompanied with games, ſpectacles, and theatrical repreſentations; and it was at this time the poets contended for the prize of poetry. Thoſe who were initiated into the celebration of theſe feaſts, repreſented, ſome Silenus; others, Pan; others, Satyrs; and in this manner appeared in public, night and day, counterfeiting drunkenneſs, dancing obſcenely, and committing all kinds of licentiouſneſs and debauchery. See Bacchus.

BACCHARIS, ploughman's spikenard. See Botany *Index.*

BACCHI, in *Mechanics*, a kind of ancient machines, in form of goats, uſed by Jupiter, in his wars againſt the giants. Rudbeck deſcribes two kinds of bacchi, one made like the battering-ram, wherewith Jupiter demoliſhed the enemy's fortifications; the other contrived to caſt fire out of, from whence the Greeks are conjectured to have framed their idea of the *chimera.*

BACCHIC, ſomething relating to the ceremonies of Bacchus. The celebrated *intaglio*, called Michael Angelo's ring, is repreſentation of a Bacchic feaſt.

Bacchic ſong, is ſometimes uſed for a *chanſon à boire*, or compoſition to inſpire jollity. But in a more proper ſenſe it is reſtrained to a dithyrambic ode or hymn.

BACCHINI, Benedict, a benedictine monk, and one of the moſt learned men in his time, was born at Borgo San Domino in 1651; and wrote a great number of books in Latin and Italian, the moſt conſiderable of which is a Literary Journal. He died at Bologna in 1721, aged 70.

BACCHIUS, a follower of Ariſtoxenus, ſuppoſed by Fabricius to have been tutor to the emperor Marcus Antoninus, and conſequently to have lived about A.C. 140. He wrote in Greek a very ſhort introduction to muſic in dialogue, which, with a Latin tranſlation thereof, Meibomius has publiſhed. It ſeems it was firſt publiſhed in the original by Merſennus, in his Commentary on the firſt ſix chapters of Geneſis; and that afterwards he publiſhed a tranſlation of it in French, which Meibomius in the preface to his edition of the ancient muſical authors, cenſures as being groſsly erroneous.

Bacchius, in *Ancient Poetry*, a kind of foot compoſed of a ſhort ſyllable and too long ones; as the word [ăvārī]. It takes its name from the god Bacchus, becauſe it frequently entered into the hymns compoſed in his honour. The Romans called it likewiſe *œnotrius, tripodius, ſaltans.*

BACCHUS, in *Heathen Mythology*, the god of wine, with whoſe fabulous adventures every ſchool-boy is acquainted. This perſonage is ſeldom named in modern times but as a ſenſual encourager of feaſt and jollity; but he was regarded in a more reſpectable light by the ancients, who worſhipped him in different countries under the following appellations: in Egypt, he was called *Oſiris;* in Myſia, *Fanaces;* in India, *Dionyſius; Liber*, throughout the Roman dominions; *Adoneus*, in Arabia; and *Pentheus*, by the Lucanians. Mythologiſts furniſh reaſons for all theſe different names given to the ſame god, which may be ſeen in the ſecond volume of Banier's Mythology.

It is natural to ſuppoſe that the Greeks and Romans, as uſual, beſtowed upon the one Bacchus which they worſhipped, the ſeveral actions and attributes of the many divinities known by that name, and by other equivalent denominations in different countries. However,

ever, antiquity chiefly distinguished two gods under the title of *Bacchus:* that of Egypt, the son of Ammon, and the same as Osiris; and that of Thebes in Bœotia, the son of Jupiter and Semele.

The Egyptian Bacchus was brought up at Nysa, a city of Arabia Felix, whence he acquired the name of *Dionysius*, or the god of Nysa; and this was the conqueror of India. Though this Bacchus of the Egyptians was one of the elder gods of Egypt, yet the son of Semele was the youngest of the Grecian deities. Diodorus Siculus tells us, that Orpheus first deified the son of Semele by the name of Bacchus, and appointed his ceremonies in Greece, in order to render the family of Cadmus, the grandfather of the Grecian Bacchus, illustrious.

The great Bacchus, according to Sir Isaac Newton, flourished but one generation before the Argonautic expedition. This Bacchus, says Hermippus, was potent at sea, conquered eastward as far as India, returned in triumph, brought his army over the Hellespont, conquered Thrace, and left music, dancing, and poetry there. And, according to Diodorus Siculus, it was the son of Semele who invented farces and theatres, and who first established a music school, exempting from all military functions such musicians as discovered great abilities in their art; on which account, says the same author, musicians formed into companies have since frequently enjoyed great privileges.

Dr Burney * observes, that the dithyrambics which gave birth to dramatic representations, are as ancient as the worship of Bacchus in Greece; and there is little doubt but that the ceremonies of his mysteries gave rise to the pomp and illusions of the theatre. Many of the most splendid exhibitions upon the stage for the entertainment of the people of Athens and Rome, being performed upon the festivals of Bacchus, gave occasion to the calling all those that were employed in them, whether for singing, dancing, or reciting, *servants of Bacchus.*

* *History of Music*, p. 298, *et seq.*

Pausanias, in his Attics, speaks of a place at Athens consecrated to *Bacchus the singer;* thus named, he says, for the same reason as Apollo is called the *chief* and *conductor* of the muses. Whence it should seem that Bacchus was regarded by the Athenians not only as the god of wine, but of song; and it must be owned, that his followers, in their cups, have been much inclined to singing ever since. Indeed we are certain, that in none of the orgies, processions, triumphs, and festivals, instituted by the ancients to the honour and memory of this prince of *bons vivans*, music was forgotten, as may be still gathered from ancient sculpture, where we find not only that musicians, male and female, regaled him with the lyre, the flute, and with song; but that he was accompanied by fawns and satyrs playing upon timbrels, cymbals, bagpipes, and horns; these Suidas calls his minstrels; and Strabo gives them the appellations of *Bacchi*, *Sileni*, *Satyri*, *Bacchæ*, *Lenæ*, *Thyæ*, *Mamillones*, *Naiades*, *Nymphæ*, and *Tityri.* These representations have furnished subjects for the finest remains of ancient sculpture; and the most voluptuous passages of ancient poetry are descriptions of the orgies and festivals of Bacchus. See Orgia.

BACCHYLIDES, a famous Greek poet, was the nephew of Simonides, and the cotemporary and rival of Pindar. Both sung the victories of Hiero at the public games. Besides odes to athletic victors, he was author of Love Verses; Prosodies; Dithyrambics; Hymns; Pæans; Hyporchemes; Parthenia, or songs to be sung by a chorus of virgins at festivals. The chronology of Eusebius places the birth of Bacchylides in the 82d Olympiad, about 450 B. C.

BACCIO, or Baccius, Andrew, a celebrated physician of the 16th century, born at St Elpideo. He practised physic at Rome with great reputation, and was first physician to Pope Sixtus V. The most scarce and valuable of his works are, 1. *De thermis.* 2. *De naturali vinorum historia.* 3. *De venenis et antidotis.* 4. *De gemmis ac lapidibus pretiosis.*

Baccio, *Fra. Bartolomeo*, called *Bartelem i di S. Marco*, a celebrated painter of history and portrait, was born at Savignano near Florence in 1469, and was a disciple of Cosumo Roselli; but his principal knowledge in the art of painting was derived from Leonardo da Vinci. He understood the true principles of design better than most masters of his time, and was also a considerable painter in perspective; which induced Raphael to have recourse to him after he had quitted the school of Perugino; and under his direction likewise Raphael studied the art of managing and uniting colours, as well as the rules of perspective. Some years after the departure of Raphael from Florence, Baccio visited Rome; and by the observations he made on the antiques, and the works of Raphael which were then the admiration of the whole world, he was extremely improved, and manifested his acquired abilities by a picture of S. Sebastian, which he finished at his return to Florence. It was so well designed, so naturally and beautifully coloured, and had so strong an expression of pain and agony, that it was removed from the place where it was publicly seen (in the chapel of a convent), as it had been observed to have made too strong an impression on the imaginations of many women who beheld it. He was very laborious, and made nature his perpetual study; he designed the naked correctly; his figures had a great deal of grace, and his colouring was admirable. He is accounted to have been the first inventor of that machine called a *layman* by the artists, and which to this day is in general use. Upon that he placed his draperies, to observe with greater exactness their natural and their more elegant folds. A capital picture of the ascension by Baccio, is in the Florentine collection. He died in 1517.

BACHELOR, or Batchelor, a common term for a man not married, or who is yet in a state of celibacy.—The Roman censors frequently imposed fines on old bachelors. Dion Halicarnasseus mentions an old constitution, by which all persons of full age were obliged to marry. But the most celebrated law of this kind, was that made under Augustus, called the *lex Julia de maritandis ordinibus;* by which bachelors were made incapable of legacies or inheritances by will, unless from their near relations. This brought many to marry, according to Plutarch's observation, not so much for the sake of raising heirs to their own estates, as to make themselves capable of inheriting those of other men.—The rabbins maintain, that, by the laws of Moses, every body, except some few particulars, is obliged in conscience to marry at 20 years of age: this makes

makes one of their 613 precepts. Hence thofe maxims fo frequent among their cafuifts, that he who does not take the neceffary meafures to leave heirs behind him, is not a man, but ought to be reputed a homicide.—Lycurgus was not more favourable; by his laws, bachelors are branded with infamy, excluded from all offices civil and military, and even from the fhows and public fports. At certain feafts they were forced to appear, to be expofed to the public derifion, and led round the market place. At one of their feafts, the women led them in this condition to the altars, where they obliged them to make *amende honourable* to nature, accompanied with a number of blows and lafhes with a rod at difcretion. To complete the affront, they forced them to fing certain fongs compofed in their own derifion.—The Chriftian religion is more indulgent to the bachelor ftate: the ancient church recommended it as in fome circumftances preferable to, and more perfect than, the matrimonial. In the canon law, we find injunctions on bachelors, when arrived at puberty, either to marry or to turn monks and profefs chaftity in earneft.—In England, there was a tax on bachelors, after 25 years of age, 12l. 10s. for a duke, a common perfon 1s. by 7 Will. III. 1695. In Britain, at prefent, they are taxed by an extra-duty on their fervants. Every man of the age of 21 years and upwards, never having been married, who fhall keep one male fervant or more, fhall pay 1l. 5s. for each above or in addition to the ordinary duties leviable for SERVANTS. Every man of the age of 21 years and upwards, never having been married, keeping one female fervant, fhall pay 2s. 6d. in addition to the former 2s. 6d.; 5s. in addition for each, if he has two female fervants; and 10s. in addition for each for three or more female fervants.

BACHELOR, was anciently a denomination given to thofe who had attained to knighthood, but had not a number of vaffals fufficient to have their banner carried before them in the field of battle; or if they were not of the order of Bannerets, were not of age to difplay their own banner, but obliged to march to battle under another's banner. It was alfo a title given to young cavaliers, who having made their firft campaign, received the military girdle accordingly. And it ferved to denominate him who had overcome another in a tournament the firft time he ever engaged.—The word *bachelor*, in a military fenfe, is derived by Cujas from *buccelarius*, a kind of cavalry, anciently in great efteem. Du Cange deduces it from *baccalaria*, a kind of fees or farms, confifting of feveral pieces of ground, each whereof contained 12 acres, or as much as two oxen would plough: the poffeffors of which baccalaria were called *bachelors*. Cafeneuve and Altaferra derive bachelor from *baculus*, or *bacillus*, "a ftaff," becaufe the young cavaliers exercifed themfelves in fighting with ftaves. Martinius derives it from *baccalaureus*, i. e. *bacca laurea donatus*, in allufion to the ancient cuftom of crowning poets with laurel, *baccis lauri*, as was the cafe with Petrarch at Rome in 1341. Alciat and Vives are of the fame opinion: nor is this etymology improbable.

Knights-BACHELORS, the moft ancient, but the loweft order of knights in England; known by the name of *knights* only. They are ftyled *knights-bachelors*, either (according to fome) as denoting their degree, *quafi bas chevaliers*; or, according to others, becaufe this title does not defcend to their pofterity.

The cuftom of the ancient Germans was to give their young men a fhield and a lance in the great council: this was equivalent to the *toga virilis* of the Romans. Before this, they were not permitted to bear arms, but were accounted as part of the father's houfehold; after it, as part of the public. Hence fome derive the ufage of knighting, which has prevailed all over the weftern world, fince its reduction by colonies, from thofe northern heroes. Knights are called in Latin *equites aurati*; *aurati*, from the gilt fpurs they wore; and *equites*, becaufe they always ferved on horfeback: for it is obfervable, that almoft all nations call their knights by fome appellation derived from a horfe. They are alfo called in our law *milites*, becaufe they formed a part, or indeed the whole, of the royal army, in virtue of their feudal tenures; one condition of which was, that every one who held a knight's fee (which in Henry II.'s time amounted to 20l. *per annum*) was obliged to be knighted, and attend the king in his wars, or pay a fine for his non-compliance. The exertion of this prerogative, as an expedient to raife money in the reign of Charles I. gave great offence, though warranted by law and the recent example of Queen Elizabeth. At the Reftoration, it was, together with all other military branches of the feudal law, abolifhed: and it now only exifts as an honorary title; though, on account of its indifcriminate attainment, not very generally regarded. It is conferred indifcriminately upon gownfmen, burghers, and phyficians, by the king's lightly touching the perfon, who is then kneeling, on the right fhoulder with a drawn fword, and faying, *Rife Sir*. See the articles KNIGHT and NOBILITY.

BACHELORS, in a univerfity fenfe, are perfons that have attained to the baccalaureate, or who have taken the firft degree in the liberal arts and fciences.

The degree of bachelor was firft introduced in the 13th century by Pope Gregory IX. but it remains ftill unknown in Italy. At Oxford, before a perfon is entitled to the degree of *bachelor of arts*, he muft have ftudied there four years; three years more to become mafter of arts; and feven more to commence bachelor of divinity.—At Cambridge, to commence bachelor of arts, he muft have been admitted near four years; and above three years more before he commence mafter; and feven more ftill to become bachelor of divinity. He may commence bachelor of law after having ftudied it fix years.—At Paris, to pafs bachelor in theology, a perfon muft have ftudied two years in philofophy and three years in theology, and held two acts of examination in the Sorbonne.—Bachelors in the canon law are admitted after two years ftudy in the fame, and fuftaining an act according to the forms. A bachelor of phyfic muft have ftudied two years in medicine after having been four years mafter of arts in the univerfity, and have ftood an examination; after which he is invefted with the fur, in order to be licenfed.—In the univerfity of Paris, before the foundation of divinity-profefforfhips, thofe who had ftudied divinity fix years were admitted to go through their courfe, whence they were called *baccalarii curfores*; and as there were two courfes, the firft employed in explaining the Bible during

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during three successive years, the second for explaining the master of the sentences for one year, those who were in their Bible-course were called *baccalarii Biblici*, and those arrived at the sentences *baccalarii sententiarii*. And, lastly, those who had gone through both were denominated *baccalarii formati*, or *formed bachelors*.

At present, *formed bachelor* denotes a person who has taken the degree regularly after the due course of study and exercises required by the statutes; by way of opposition to a *current bachelor*, who is admitted in the way of grace, or by diploma.

We also find mention of bachelors of the church, *baccalarii ecclesiæ*. The bishop with his canons and *baccalarii, cum consilio et consensu omnium canonicorum suorum et baccalariorum*.

Bachelors, in the livery companies of London, are those not yet admitted to the livery. These companies generally consist of a master, two wardens, the livery, and the bachelors, who are yet but in expectation of dignity in the company, and have their function only in attendance on the master and wardens. They are also called *yeomen*.

Bachelor is also a name given in the six conpanies of merchants at Paris to the elders, and such as, having served the offices, have a right to be called by the masters and wardens to be present with them, and assist them in some of the functions, particularly in what relates to the *chef-d'œuvres* or master-pieces of such as are candidates for being admitted masters.

BACHERAC, a town of the palatinate of the Rhine, situated on the western shore of that river, in E. Long. 7°. and N. Lat. 58°. It is remarkable for excellent wine, from thence called *Bacherac*.

BACHIAN, one of the Molucca islands, belonging to the Dutch; situated under the equator, in E. Long. 125°.

BACHU, a city of Shirvan in Persia, and the best haven in the Caspian sea. It is defended by a double wall, as also by a ditch and redoubts, made by the Russians when they were masters of the place. It had a sumptuous castle, but it is reduced to a ruinous state by the Russians. Formerly many merchants resided here, and carried on a considerable traffic in raw silk; but that commerce is now given up. All the country round is much impregnated with sulphur, which renders the water very unpleasant. The neighbourhood of this city supplies the countries adjacent with naphtha, brimstone, and rock-salt; and is the only place thereabouts which produces saffron. Round Bachu are several very steep craggy mountains, on which are strong watch-towers. E. Long. 49. 5. N. Lat. 40. 0.

BACK, Back-Bone, or Spine. See Anatomy *Index*.

Back, in the *Manege*, and among *Farriers*. A horse's back should be straight, not hollow, which is called *saddle-backed*: horses of this kind are generally light, and carry their heads high, but want in strength and service. A horse with a weak back is apt to stumble. In the French riding-schools, to mount a horse *à dos*, is to mount him bare-backed, without a saddle.

Back-gammon

Back-Gammon, an ingenious game played with dice, upon a table, by two persons.

Manner of playing the game. The table is divided into two parts, upon which there are 24 black and white spaces, called *points*. Each adversary has 15 men, black and white, to distinguish them; and they are disposed of in the following manner: Supposing the game to be played into the right-hand table, two are placed upon the ace-point in the adversary's table, five upon the six point in the opposite table, three up on the cinque point in the hithermost table, and five on the six point in the right-hand table. The grand object in this game is for each player to bring the men round into his right-hand table, by throwing with a pair of dice those throws that contribute towards it, and at the same time prevent the adversary doing the like. The first best throw upon the dice is esteemed aces, because it stops the six point in the outer table, and secures the cinque in the thrower's table; whereby the adversary's two men upon the thrower's ace point cannot get out with either quatre, cinque, or six. This throw is an advantage often given to the antagonist by the superior player.

When he carries his men home in order to lose no point, he is to carry the most distant man to his adversary's bar point, that being the first stage he is to place it on; the next stage is six points farther, viz. in the place where the adversary's five men are first placed out of his tables. He must go on in this method till all his men are brought home, except two, when by losing a point, he may often save the gammon, by throwing two fours or two fives.

When a hit is only played for, he should endeavour to gain either his own or adversary's cinque point; and if that fails by his being hit by the adversary, and he finds him forwarder than himself, in that case he must throw more men into the adversary's tables; which is done in this manner: He must put a man upon his cinque or bar point; and if the adversary neglects to hit it, he may then gain a forward game instead of a back game: but if the adversary hits him, he should play for a back game; and then the greater number of men which are taken up makes his game the better, because by these means he will preserve his game at home: and then he should endeavour to gain both his adversary's ace and trois points, or his ace and deuce points, and take care to keep three men upon the adversary's ace point, that in case he hits him from thence, that point may remain still secure to himself.

A back game should not be played for at the beginning of a set, because it would be a great disadvantage, the player running the risk of a gammon to win a single hit.

Rules for playing at setting out all the throws on the dice, when the player is to play for a gammon or for a single hit (A). 1. Two aces are to be played on the cinque

(A) The rules marked thus † are for a gammon only; those marked thus * are for a hit only.

Back-gammon.

cinque point and bar point, for a gammon or for a hit. 2. Two fixes, to be played on the adverfary's bar point and on the thrower's bar point, for a gammon or for a hit. 3. † Two trois, to be played on the cinque point, and the other two on the trois point in his own tables, for a gammon only. 4. †. Two deuces, to be played on the quatre point in his own tables, and two to be brought over from the five men placed in the adverfary's tables for a gammon only. 5. † Two fours, to be brought over from the five men placed in the adverfary's tables, and to be put upon the cinque point in his own tables for a gammon only. 6. Two fives, to be brought over from the five men placed in the adverfary's tables, and to be put on the trois point in his own tables, for a gammon or for a hit. 7. Size ace, he muft take his bar point for a gammon or for a hit. 8. Size deuce, a man to be brought from the five men placed in the adverfary's tables, and to be placed in the cinque point in his own tables, for a gammon or for a hit. 9. Six and three, a man to be brought from the adverfary's ace point, as far as he will go, for a gammon or for a hit. 10. Six and four, a man to be brought from the adverfary's ace point, as far as he will go, for a gammon or for a hit. 11. Six and five, a man to be carried from the adverfary's ace point, as far as he can go, for a gammon or for a hit. 12. Cinque and quatre, a man to be carried from the adverfary's ace point, as far as he can go, for a gammon or for a hit. 13. Cinque trois, to make the trois point in his table, for a gammon or for a hit. 14. Cinque deuce, to play two men from the five placed in the adverfary's tables, for a gammon or for a hit. 15. † Cinque ace, to bring one man from the five placed in the adverfary's tables for the cinque, and to play one man down on the cinque point in his own tables for the ace, for a gammon only. 16. Quatre trois, two men to be brought from the five placed in the adverfary's tables, for a gammon or for a hit. 17. Quatre deuce, to make the quatre point in his own tables, for a gammon or for a hit. 18. † Quatre ace, to play a man from the five placed in the adverfary's tables for the quatre; and for the ace, to play a man down upon the cinque point in his own tables, for a gammon only. 19. † Trois deuce, two men to be brought from the five placed in the adverfary's tables, for a gammon only. 20. Trois ace, to make the cinque point in his own tables, for a gammon or for a hit. 21. † Deuce ace, to play one man from the five men placed in the adverfary's table for the deuce; and for the ace to play a man down upon the cinque point in his own tables, for a gammon only. 22. * Two trois, two of them to be played on the cinque point in his own tables, and with the other two he is to take the quatre point in the adverfary's tables. 23. * Two deuces, two of them are to be played on the quatre point in his own tables, and with the other two he is to take the trois point in the adverfary's tables. By playing thefe two cafes in this manner, the player avoids being fhut up in the adverfary's tables, and has the chance of throwing out the tables to win the hit.

24. * Two fours, two of them are to take the adverfary's cinque point in the adverfary's tables, and for the other two, two men are to be brought from the five placed in the adverfary's tables. 25. * Cinque ace, the cinque fhould be played from the five men placed in the adverfary's tables, and the ace from the adverfary's ace point. 26. * Quatre ace, the quatre to be played from the five men placed in the adverfary's ace point. 27. * Deuce ace, the deuce to be played from the five men placed in the adverfary's tables, and the ace from the adverfary's ace point.

The three laft chances are played in this manner; becaufe an ace being laid down in the adverfary's tables, there is a probability of throwing deuce ace, trois deuce, quatre trois, or fize cinque, in two or three throws; either of which throws fecures a point, and gives the player the beft of the hit.

Cautions, &c. The player muft underftand by the directions given to play for a gammon, that he is to make fome blots on purpofe, the odds being in his favour that they are not hit: but if it fhould happen that any blot is hit, as in this cafe there will be three men in the adverfary's tables, he muft then endeavour to fecure the adverfary's cinque, quatre, or trois point, to prevent a gammon, and muft be very cautious of his fourth man's not being taken up.

He muft not crowd his game at any time if he can help it; that is to fay, he fhould not put many men either upon the trois or deuce points in his own tables, being the fame as lofing thofe men, not having them in play. Befides, by crowding the game, and attempting to fave a gammon, the player is often gammoned. His game being crowded in his own tables, the adverfary has room to play as he thinks proper.

The following calculations will fhow the odds of entering a fingle man upon any certain number of points; and accordingly the game fhould be played.

It is neceffary to know that there are thirty-fix chances upon two dice, and the points that are upon thefe thirty-fix chances are as follow:

Viz.		Points.
2 Aces	- -	4
2 Deuces	- -	8
2 Trois	- -	12
2 Fours	- -	16
2 Fives	- -	20
2 Sixes	- -	24
6 And 5 twice	-	22
6 And 4 twice	-	20
6 And 3 twice	-	18
6 And 2 twice	-	16
6 And 1 twice	-	14
5 And 4 twice	-	18
5 And 3 twice	-	16
5 And 2 twice	-	14
5 And 1 twice	-	12
4 And 3 twice	-	14
4 And 2 twice	-	12
4 And 1 twice	-	10
3 And 2 twice	-	10
3 And 1 twice	-	8
2 And 1 twice	-	6

Divide by 36)294(8

and it proves, that upon an average the player has a right to 8 points each throw.

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The

Back-gammon.

The chances upon two dice calculated for back-gammon are as follow;

	2 Sixes - -	1
	2 Fives - -	1
	2 Fours - -	1
	2 Trois - -	1
	2 Deuces - -	1
†	2 Aces - -	1
	6 And 5 twice -	2
	6 And 4 twice -	2
	6 And 3 twice -	2
	6 And 2 twice -	2
†	6 And 1 twice -	2
	5 And 4 twice -	2
	5 And 3 twice -	2
	5 And 2 twice -	2
†	5 And 1 twice -	2
	4 And 3 twice -	2
	4 And 2 twice -	2
†	4 And 1 twice -	2
	3 And 2 twice -	2
†	3 And 1 twice -	2
†	2 And 1 twice -	2
		36

As it may seem difficult to find out by this table of thirty-six chances what are the odds of being hit upon a certain or flat die, let the following method be pursued.

The player may observe in the table that what are thus † marked are,

†	2 Aces - -	1
†	6 And 1 twice -	2
†	5 And 1 twice -	2
†	4 And 1 twice -	2
†	3 And 1 twice -	2
†	2 And 1 twice -	2
	Total,	11
	When deducted from -	36
	There remains - -	25

So that it appears it is twenty-five to eleven against hitting an ace upon a certain or flat die.

The above method holds good with respect to any other flat die. For example, what are the odds of entering a man upon 1, 2, 3, 4, or 5 points?

Answer.

To enter it upon	for against		for ag.
1 point is	11 to 25	Or about -	4 to 9
2 points	20 - 16	-	5 4
3 -	27 - 9	-	3 1
4 -	32 - 4	-	8 1
5 -	35 - 1	-	35 1

The following table shows the odds of hitting with any chance, in the reach of a single die.

To hit upon	for against		for ag.
1 is -	11 to 25	Or about -	4 to 9
2 -	12 - 24	-	1 - 2
3 -	14 - 22	-	2 - 3
4 -	15 - 21	-	5 - 7
5 -	15 - 21	-	5 - 7
6 -	17 - 19	-	8½ 9½

The odds of hitting with double dice are as follow:

To hit upon	for against		for ag.
7 is -	6 to 30	Or about -	1 to 5
8 -	6 30	- -	1 5
9 -	5 31	- -	1 6
10 -	3 33	- -	1 11
11 -	2 34	- -	1 17
12 -	1 36	- -	1 35

How to find out the odds of being hit upon a six, by the table of thirty-six chances.

2 Sixes - - -	1
2 Trois - - - -	1
2 Deuces - - - -	1
6 And 5 twice - - -	2
6 And 4 twice - -	2
6 And 3 twice - - -	2
6 And 2 twice - - -	2
6 And 1 twice - - -	2
5 And 1 twice - - -	2
4 And 2 twice - - - -	2
	17
Which deducted from - -	36
There remains - -	19

By which it appears to be 19 to 17 against being hit upon a six.

The odds on the hits.

2 Love is about - - -	5 to 2
2 to 1 is - - -	2 1
1 Love is - - -	3 2

Directions for the player to bear his men. If a player has taken up two of the adversary's men, and happens to have two, three, or more points made in his own tables, he should spread his men, that he either may take a new point in his tables, or be ready to hit the man which the adversary may happen to enter. If he finds upon the adversary's entering, that the game is upon a par, or that the advantage is on his own side, he should take the adversary's man up whenever he can, it being 25 to 11 that he is not hit: except when he is playing for a single hit only; then, if playing the throw otherwise gives him a better chance for it, he ought to do it.

It being five to one against his being hit with double dice, he should never be deterred from taking up any one man of the adversary's.

If he has taken up one of the adversary's men, and should happen to have five points in his own tables, and forced to leave a blot out of his tables, he should endeavour to leave it upon doublets preferable to any other chance, because in that case the odds are 35 to one that he is not hit; whereas it is only 17 to one but he is hit upon any other chance.

When the adversary is very forward, a player should never move a man from his own quarter, trois, or deuce points, thinking to bear that man from the point where he put it, as nothing but high doublets can give him any chance for the hit. Instead of playing an ace or a deuce from any of those points, he should play them from his own size or highest points, so that throwing two fives, or two fours, his size and cinque points being eased, would be a considerable advantage

 to

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to him; whereas had they been loaded, he muſt have been obliged to play otherwiſe.

It is the intereſt of the adverſary to take up the player as ſoon as he enters. The blot ſhould be left upon the adverſary's loweſt point; that is to ſay, upon his deuce point rather than upon his trois point; or upon his trois point rather than his quatre point, or upon his quatre point preferable to his cinque point, for a reaſon before mentioned; all the men the adverſary plays upon his trois or his deuce points are deemed loſt, being greatly out of play; ſo that thoſe men not having it in their power to make his cinque point, and his game being crowded in one place and open in another, the adverſary muſt be greatly annoyed by the player.

If the player has two of the adverſary's men in his tables, he has a better chance for a hit than if he had more, provided his game is forwarder than that of his antagoniſt's; for if he had three or more of the adverſary's men in his tables, he would ſtand a worſe chance to be hit.

When a player is running to ſave the gammon, if he ſhould have two men upon his ace point, and ſeveral men abroad, although he ſhould loſe one point or two in putting his men into his tables, it is his intereſt to leave a man upon the adverſary's ace point, becauſe it will prevent his adverſary from bearing his men to the greateſt advantage, and at the ſame time the player will have a chance of the adverſary's making a blot, which he may chance to hit. However, if a player finds upon a throw, that he has a probability of ſaving his gammon, he ſhould never wait for a blot, as the odds are greatly againſt his hitting it, but ſhould embrace that opportunity.

How to calculate the odds of ſaving or winning the gammon. Suppoſe the adverſary has ſo many men abroad as require three throws to put them into his tables, and at the ſame time that the player's tables are made up, and that he has taken up one of the adverſary's men; in this caſe, it is about an equal wager that the adverſary is gammoned. For in all probability the player has bore two men before he opens his tables, and when he bears the third man, he will be obliged to open his ſize or cinque point. It is then probable, that the adverſary is obliged to throw twice before he enters his men in the player's tables, twice more before he puts that man into his own tables, and three throws more to put the men which are abroad into his own tables, in all ſeven throws. Now the player having 12 men to bear, he may be forced to make an ace or a deuce twice before he can bear all his men, and conſequently will require ſeven throws in bearing them; ſo that, upon the whole, it is about equal whether the adverſary is gammoned or not.

Suppoſe a player has three men upon his adverſary's ace point and five points in his own tables, and that the adverſary has all his men in his tables, three upon each of his five higheſt points. Has the player a probability of gammoning his adverſary or not?

	Points.
For bearing three men from his 6th point is - -	18
From his 5th point - -	15
	33
Carried forward - -	33
From his 4th point - -	12
From his 3d point - - -	6
From his 2d point - -	9
In all	60
Bringing his three men from the adverſary's ace point to his ſize point in his own tables, being 18 points each, and making together - - -	54
There muſt remain - - -	6

It is plain from this calculation, that the player has much the beſt of the probability of the gammon, excluſive of one or more blots which the adverſary is liable to make in bearing his men, ſuppoſing at the ſame time the throws to be upon an equality.

Suppoſe two blots are left, either of which cannot be hit but by double dice; one muſt be hit by throwing eight and the other by throwing nine; ſo that the adverſary has only one die to hit either of them. What are the odds of hitting either of them? The chances of two dice being in all - - 36

The chances to hit 8 are 6 and 2 twice -	2
5 and 3 twice - - -	2
2 Deuces - - - -	1
2 Fours - - - -	1
The chances to hit 9 are 6 and 3 twice -	2
5 and 4 twice - - -	2
2 Trois - - -	1
For hitting in all - - -	11
Chances for not hitting, remain -	25

So that the odds are 25 to 11 againſt hitting either of theſe blots.

This method may be taken to find out the odds of hitting three, four, or five blots upon double dice; or blots made upon double and ſingle dice at the ſame time. After knowing how many chances there are to hit any of thoſe blots, they muſt be added all together, and then ſubtracted from the number 36, which are the chances of the two dice, and the queſtion is ſolved.

A critical caſe for a Back-game. Suppoſe the foregame to be played by A, and that all his men are placed as uſual; B has fourteen of his men placed upon his adverſary's ace point and one man upon his adverſary's deuce point, and B is to throw. Who has the beſt of the hit?—*Anſwer:* A has the beſt of it, gold to ſilver: becauſe, if B does not throw an ace to take his adverſary's deuce point, which is 25 to 11 againſt him, A will take up B's men in his tables, either ſingly or to make points; and then if B ſecures either A's deuce or trois point, A will put as many men down as poſſible, in order to hit, and thereby get a back-game. It is evident that the back-game is very powerful; conſequently, whoever practiſes it muſt become a greater proficient at the game than he could by any other means.

Another critical caſe. Suppoſe A to have five men placed upon his ſize point, as many upon his quatre point, and the ſame number upon his deuce point, all in his own tables. At the ſame time, let us ſuppoſe B to have three men placed upon A's ace point, as many

Back-gammon.

many upon A's trois point, and the ſame number upon A's cinque point, in his own tables, and three men placed as uſual out of his tables. Who has the beſt of the hit?—*Anſwer:* The game is equal till B has gained his cinque and quatre points in his own tables; which if he can effect, and by playing two men from A's cinque point, in order to force his adverſary to blot by throwing an ace, which ſhould B hit, he will have the beſt of the hit.

A caſe of curioſity and inſtruction: in which is ſhown the probability of making the hit laſt by one of the players for many hours, although they ſhall both play as faſt as uſual. Suppoſe B to have bore 13 men, and that A has his fifteen men in B's tables, viz. three men upon his ſize point, as many upon his cinque point, three upon his quatre point, the ſame number upon his trois point, two upon his deuce point, and one upon his ace point. A in this ſituation can prolong it, as aforeſaid by bringing his 15 men home, always ſecuring ſix cloſe points till B has entered his two men, and brought them upon any certain point; as ſoon as B has gained that point, A will open an ace, deuce, or trois point, or all of them; which done, B hits one of them, and A taking care to have two or three men in B's tables, is ready to hit that man; and alſo he being certain of taking up the other man, has it in his power to prolong the hit almoſt to any length, provided he takes care not to open ſuch points as two fours, two fives, or two ſixes, but always to open the ace, deuce, or trois points, for B to hit him.

A critical game to play. Suppoſe A and B place their men for a hit in the following manner: A to have three men upon the ſize point in his own tables, three men out of his tables upon the uſual point, and nine men upon his adverſary's ace, deuce, and trois points; that is, three upon each: and ſuppoſe B's men to be placed in his own and his adverſary's tables in the ſame order. So ſituated, the beſt player ſhould win the hit. The game being ſo equal, that in this caſe the dice ſhould be thrown for. Now if A throws firſt, he ſhould endeavour to gain his adverſary's cinque point: this being done, he ſhould lay as many blots as poſſible, to tempt B to hit him, as it puts him backward, and A thereby gains an advantage. A ſhould always endeavour to have three men upon each of his adverſary's ace and deuce points; becauſe when B makes a blot, theſe points will remain ſecure, and when A has bore five, ſix, or more men, A yet may ſecure ſix cloſe points out of his tables, in order to prevent B from getting his man home, at which time he ſhould calculate who has the beſt of the hit. If he finds that B is foremoſt, he ſhould then try to lay ſuch blots as may be taken up by his adverſary, that he may have a chance of taking up another man, in caſe B ſhould happen to have a blot at home.

Laws of Back-gammon. 1. If a man is taken from any point, it muſt be played; if two men are taken from it, they alſo muſt be played. 2. A man is not ſuppoſed to be played till it is placed upon a point and quitted. 3. If a player has only fourteen men in play, there is no penalty inflicted, becauſe by his playing with a leſſer number than he is entitled to, he plays to a diſadvantage for want of the deficient man to make up his tables. 4. If he bears any number of men before he has entered a man taken up, and which of courſe he was obliged to enter, ſuch men ſo borne muſt be entered again in the adverſary's tables as well as the man taken up. 5. If he has miſtaken his throw and played it, and his adverſary has thrown, it is not in the choice of either of the players to alter it, unleſs they both agree ſo to do.

Back-painting.

Back-Painting, the method of painting mezzotinto prints, paſted on glaſs, with oil-colours. See Mezzotinto.

The art conſiſts chiefly in laying the print upon a piece of crown-glaſs, of ſuch a ſize as fits the print.

In order to do this, take your print, and lay it in clean water for two days and two nights, if the print be on very ſtrong, cloſe, and hard gummed paper: but if upon an open, ſoft, ſpongy paper, two hours will ſometimes ſuffice, or more, according as the paper is.

The paper or picture having been ſufficiently ſoaked, take it out and lay it upon two ſheets of paper, and cover it with two more; and let it lie there a little to ſuck out the moiſture.

In the mean time, take the glaſs the picture is to be put upon, and ſet it near the fire to warm; take Straſburg turpentine, warm it over the fire till it is grown fluid, then with a hog's hair bruſh ſpread the turpentine very ſmoothly and evenly on the glaſs.

When this has been done, take the mezzotinto print from between the papers, and lay it upon the glaſs; beginning firſt at one end, rubbing it down gently as you go on, till it lie cloſe, and there be no wind bladders between.

Then, with your fingers, rub or roll off the paper from the backſide of the print, till it looks black, i. e. till you can ſee nothing but the print, like a thin film, left upon the glaſs, and ſet it by to dry.

When it is dry, varniſh it over with ſome white tranſparent varniſh, that the print may be ſeen through it; and then it is fit for painting.

The utmoſt care will be neceſſary in rubbing or rolling the paper off the print, ſo as not to tear it, eſpecially in the light parts.

You may, inſtead of ſoaking your prints two days and two nights, roll them up and boil them for about two hours, more or leſs, according to the quality of the paper, in water; and that will render it as fit for rubbing, rolling, or peeling, as the other way.

This being done, and your oil-colours prepared, ground very fine, and tempered up very ſtiff, lay on the back ſide of the tranſparent prints ſuch colours as each particular part requires; letting the maſter-lines of the print ſtill guide your pencil, and ſo each particular colour will lie fair to the eye on the other ſide of the glaſs, and look almoſt as well as a painted piece, if it be done neatly.

The ſhadows of the print are generally ſufficient for the ſhadow of every colour; but if you have a mind to give a ſhadow by your pencil, then let the ſhadows be laid on firſt, and the other colours afterward.

In laying on colours in this kind of back-painting, you need not be curious as to the laying them on ſmooth. This is not at all requiſite here, where the chief aim is only to have the colours appear well on the fore ſide of the print; and therefore the only care to be

Back-staff || Backeleer.

be used in this work, is to lay the colours on thick enough, that its body may strike the colour of it plainly through the glass.

Back-Staff, a name formerly given to a sea-quadrant invented by Captain Davis: because the back of the artist is turned towards the sun at the time of observation. See Quadrant.

Back-Stays, of a ship, are ropes belonging to the main-mast and fore-mast, and the masts belonging to them; serving to keep them from pitching forwards or overboard.

Back-Tack, in *Scotch Law*: When a wadsetter, instead of possessing the wadset-lands, grants a tack thereof to the reverser for payment of a certain sum in name of tack-duty, that tack is called a *back-tack*.

Back-Worm. See Filanders.

BACKER, or Bakker, Jaques, a painter of history, was born at Antwerp in 1530; and learned the principles of painting from his father, who was an artist very knowing in his profession, though his works were in no great estimation. After the death of his father, he lived in the house of Jacopo Palermo, a dealer in pictures, who avariciously took care to keep him incessantly employed, and sent his paintings to Paris to be disposed of, where they happened to be exceedingly admired. The judicious were very eager to purchase them; and though the transactor sold them at a great price, yet the poor artist was not proportionably rewarded, but continued in the same obscure and depressed condition. His merit, indeed, was universally allowed, but his name, and the narrowness of his circumstances, were as universally unknown. He had a clean light manner of penciling, and a tint of colour that was extremely agreeable.—He died in 1560.

Backer, or Bakker, *Jacob*, painter of portrait and history, was born at Harlingen in 1609, but spent the greatest part of his life at Amsterdam; and by all the writers on this subject, he is mentioned as an extraordinary painter, particularly of portraits, which he executed with strength, spirit, and a graceful resemblance. He was remarkable for an uncommon readiness of hand and freedom of pencil; and his incredible expedition in his manner of painting, appeared even in one portrait of a lady from Haerlem, that he painted at half length, which was begun and finished in one day, though he adorned the figure with rich drapery and several ornamental jewels. He also painted historical subjects with good success; and in that style there is a fine picture of Cimon and Iphigenia, which is accounted by the connoisseurs an excellent performance. In designing academy figures his expression was so just, and his outline so correct, that he obtained the prize from all his competitors; and his works are still bought up at very high prices in the Low Countries. In the collection of the Elector Palatine there is an excellent head of Brouwer, painted by this master; and in the Carmelites church at Antwerp is preserved a capital picture of the Last Judgment, which is well designed and well coloured. He died in 1651.

BACKEREEL, called Bacquerelli, *William*, a painter of history, was born at Antwerp, and was a disciple of Rubens, at the same time that Vandyck was educated in that school. When each of them quitted that master, and commenced painters, Backereel was very little inferior to Vandyck, if not nearly his equal. And this may be manifestly seen in the works of the former, which are in the church of the Augustin monks at Antwerp; where those two great artists painted in competition, and both were praised for their merit in their different ways; but the superiority was never determined in favour either of the one or the other. He had likewise a good taste for poetry; but, by exercising that talent too freely, in writing satires against the Jesuits, these ecclesiastics pursued him with unremitted revenge, till they compelled him to fly from Antwerp; and by that means deprived his own country of such paintings as would have contributed to its perpetual honour.—Sandrart takes notice, that in his time there were seven or eight painters, who were very eminent, of the name of Backereel, in Italy and the Low Countries.

Backhuysen.

BACKHUYSEN, Ludolph, an eminent painter, was born at Embden in 1631, and received his earliest instruction from Albert Van Everdingen; but acquired his principal knowledge by frequenting the painting rooms of different great masters, and observing their various methods of touching and colouring. One of these masters was Henry Dubbels, whose understanding in his art was very extensive: and he was as remarkably communicative of his knowledge to others. From him Backhuysen obtained more real benefit than from all the painters of his time, either by studying their works, or personally conversing with them. His subjects were sea-pieces, ships, and sea-ports. He had not practised very long when he became the object of general admiration; so that even his drawings were sought after, and several of them were bought up at 100 florins a-piece. It was observed of him, that while he was painting, he would not suffer even his most intimate friends to have access to him, lest his fancy might be disturbed, and the ideas he had formed in his mind be interrupted. He studied nature attentively in all her forms; in gales, calms, storms, clouds, rocks, skies, lights, and shadows; and he expressed every subject with so sweet a pencil, and such transparence and lustre, as placed him above all the artists of his time in that style, except the younger Vanderyelde, who is deservedly esteemed the first in that manner of painting. It was a frequent custom with Backhuysen, whenever he could procure resolute mariners, to go to sea in a storm, in order to store his mind with grand images, directly copied from nature, of such scenes as would have filled any other head and heart with terror and dismay; and the moment he landed he always impatiently ran to his palette to secure those incidents of which the traces might by delay be obliterated.—He perfectly understood the management of the chiaroscuro, and by his skill in that part of his art, he gave uncommon force and beauty to his objects. He observed strictly the truth of perspective, in the distances of his vessels, the receding of the grounds on the shores, and the different buildings which he described in the sea-ports: whether they were the result of his own imagination, or sketched, as he usually did, after nature. His works may easily be distinguished by an observant eye, from the freedom and neatness of his touch; from the clearness and natural agitation or quiescence of the water; from a peculiar tint in his clouds and skies; and also from the exact proportions of of his ſhips, and the gracefulneſs of their poſition. For the burgomaſters of Amſterdam he painted a large picture, with a multitude of veſſels, and a view of the city at a diſtance, for which they gave him thirteen hundred guilders, and a conſiderable preſent; which picture they afterwards preſented to the king of France, who placed it in the Louvre. No painter was ever more honoured by the viſits of kings and princes than Backhuyſen; the king of Pruſſia was one of the number; and the czar Peter the Great took delight to ſee him paint, and often endeavoured to draw after veſſels which he had deſigned. He was remarkably aſſiduous, and yet it ſeems aſtoniſhing to conſider the number of pictures which he finiſhed, and the exquiſite manner in which they are painted. He died in 1709.

BACKING, in *Horſemanſhip*. See HORSEMANSHIP.

Backing the Sails, in *Navigation;* to arrange them in a ſituation that will force the ſhip to retreat, or move backwards. This is, however, only done in narrow channels, when a ſhip is carried along ſidewiſe by the tide or current, and wants to avoid any thing that may interrupt her progreſs, as ſhoals, veſſels at anchor, &c. or in the line of battle, when a ſhip wants to be immediately oppoſite to another with which ſhe is engaged.

BACKS, among dealers in leather, denote the thickeſt and beſt tanned hides, uſed chiefly for ſoles of ſhoes.

BACKS, in *Brewing* and *Diſtilling*. See BAC.

BACULARIUS, in writers of the middle age, an eccleſiaſtical apparitor, or verger; who carries a ſtaff, *baculus*, in his hand, as an enſign of his office.

BACON, ſwines fleſh ſalted, and dried in the chimney.—Old hiſtorians and law-writers ſpeak of the *ſervice of the bacon*, a cuſtom in the manor of Whichenacre in Staffordſhire, and priory of Dunmore in Eſſex; in the former of which places, by an ancient grant of the lord, a flitch of bacon, with half a quarter of wheat, was to be given to every married couple who could ſwear, that, having been married a year and a day, they would never within that time have once exchanged their mate for any other perſon on earth, however richer, fairer, or the like. But they were to bring two of their neighbours to ſwear with them that they believed they ſwore the truth. On this the lord of another neighbouring manor, of Rudlow, was to find a horſe ſaddled, and a ſack to carry the bounty in, with drums and trumpets, as far as a day's journey out of the manor: all the tenants of the manor being ſummoned to attend, and pay ſervice to the bacon. The bacon of Dunmore, firſt erected under Henry III. was on much the ſame footing; only the tenor of the oath was, that the parties had never once repented, or wiſhed themſelves unmarried again.

BACON, *Roger*, a Franciſcan friar of amazing genius and learning, was born near Ilcheſter in Somerſetſhire, in the year 1214. He began his ſtudies at Oxford; but in what ſchool or college is uncertain. Thence he removed to the univerſity of Paris, which, in thoſe times, was eſteemed the centre of literature. Here, we are told, he made ſo rapid a progreſs in the ſciences, that he was eſteemed the glory of that univerſity, and was much careſſed by ſeveral of his countrymen, particularly by Robert Grouthead, afterwards biſhop of Lincoln, his ſingular friend and patron. About the year 1240, he returned to Oxford; and aſſuming the Franciſcan habit, proſecuted his favourite ſtudy of experimental philoſophy with unremitting ardour and aſſiduity. In this purſuit, in experiments, inſtruments, and in ſcarce books, he tells us, he ſpent, in the ſpace of 20 years, no leſs than 2000l; which, it ſeems, was given him by ſome of the heads of the univerſity, to enable him to proſecute his noble inquiries. But ſuch extraordinary talents, and aſtoniſhing progreſs in ſciences, which, in that ignorant age, were totally unknown to the reſt of mankind, whilſt they raiſed the admiration of the more intelligent few, could not fail to excite the envy and malice of his illiterate fraternity; who found no difficulty of poſſeſſing the vulgar with the notion of Bacon's dealing with the devil. Under this pretence, he was reſtrained from reading lectures; his writings were confined to his convent; and finally, in 1278, he himſelf was impriſoned in his cell. At this time he was 64 years of age. Nevertheleſs, being permitted the uſe of his books, he went on in the rational purſuit of knowledge, corrected his former labours, and wrote ſeveral curious pieces. When he had been 10 years in confinement, Jerom de Aſcoli being elected pope, Bacon ſolicited his holineſs to be releaſed; in which, it ſeems, he did not immediately ſucceed. However, towards the latter end of that pope's reign, he obtained his liberty, and ſpent the remainder of his life in the college of his order, where he died in the year 1294, in the 80th year of his age, and was buried in the Franciſcan church. Such are the few particulars which the moſt diligent reſearches have been able to diſcover concerning this very great man; who, like a ſingle bright ſtar in a dark hemiſphere, ſhone forth the glory of his country, and the pride of human nature. His works are, 1. *Epiſtola fratris Rogeri Baconis de ſecretis operibus artis et naturæ, et de nullitate magiæ*. Paris, 1542, 4to. Baſil, 1593, 8vo. 2. *Opus majus*. Lond. 1733, fol. publiſhed by Dr Jebb. 3. *Theſaurus chemicus*, Francf. 1603, 1620. This was probably the editor's title; but it contains ſeveral of our author's treatiſes on this ſubject. Theſe printed works of Bacon contain a conſiderable number of eſſays, which, in the catalogue of his writings by Bale, Pits, &c. have been conſidered as diſtinct books; but there remain in different libraries ſeveral manuſcripts not yet publiſhed. By an attentive peruſal of his works, the reader will be aſtoniſhed to find, that this great luminary of the 13th century was a great linguiſt and a ſkilful grammarian, that he was well verſed in the theory and practice of perſpective; that he underſtood the uſe of convex and concave glaſſes, and the art of making them: that the *camera obſcura*, burning-glaſſes, and the power of the teleſcope were known to him; that he was well verſed in geography and aſtronomy; that he knew the great error in the kalendar, aſſigned the cauſe, and propoſed the remedy; that he underſtood chronology well; that he was an adept in chemiſtry, and was really the inventor of gun-powder; that he poſſeſſed great knowledge in the medical art; that he was an able mathematician, logician, metaphyſician, and theologiſt.

BACON, *Sir Nicholas*, lord keeper of the great ſeal in the reign of Queen Elizabeth, was born at Chiſlehurſt, in Kent, in 1510, and educated at the univerſity

Bacon.

ty of Cambridge; after which he travelled into France, and made ſome ſtay at Paris. On his return, he ſettled in Gray's Inn, and applied himſelf with ſuch aſſiduity to the ſtudy of the law, that he quickly diſtinguiſhed himſelf ſo, that on the diſſolution of the monaſtery of St Edmund's Bury, in Suffolk, he had a grant from King Henry VIII. in the 36th year of his reign, of ſeveral manors. In the 38th of the ſame king, he was promoted to the office of attorney in the court of wards, which was a place both of honour and profit. In this office he was continued by King Edward VI.; and in 1552 he was elected treaſurer of Gray's Inn. His great moderation and conſummate prudence preſerved him through the dangerous reign of Queen Mary. In the very dawn of that of Elizabeth he was knighted; and on the 22d of December 1558, the great ſeal of England, being taken from Nicolas Heath archbiſhop of York, was delivered to him with the title of *lord keeper*, and he was alſo made one of the queen's privy council. He had a conſiderable ſhare in the ſettling of religion: as a ſtateſman, he was remarkable for a clear head and deep counſels: but his great parts and high preferment were far from raiſing him in his own opinion, as appears from the modeſt anſwer he gave Queen Elizabeth, when ſhe told him his houſe at Redgrave was too little for him: "Not ſo, madam, (returned he); but your majeſty has made me too great for my houſe." After having had the great ſeal more than 20 years, this able ſtateſman and faithful counſellor was ſuddenly removed from this life, as Mr Mallet informs us, by the following accident: he was under the hands of the barber, and thinking the weather warm, had ordered a window before him to be thrown open, but fell aſleep as the current of freſh air was blowing in upon him, and awakened ſome time after diſtempered all over. He was immediately removed into his bed-chamber, where he died a few days after, on the 26th of February 1578-9, equally lamented by the queen and her ſubjects. He was buried in St Paul's, where a monument was erected to him, which was deſtroyed by the fire of London in 1666. Mr Granger obſerves, that he was the firſt lord keeper that ranked as lord chancellor; and that he had much of that penetrating genius, ſolidity, and judgment, perſuaſive eloquence, and comprehenſive knowledge of law and equity, which afterwards ſhone forth with ſo great a luſtre in his ſon, who was as much inferior to his father in point of prudence and integrity, as his father was to him in literary accompliſhments.

Bacon, *Francis*, lord high chancellor of England under King James I. was ſon of Sir Nicholas Bacon, lord keeper of the great ſeal in the reign of Queen Elizabeth, by Anne daughter of Sir Anthony Cook, eminent for her ſkill in the Latin and Greek tongues. He was born in 1560; and ſhowed ſuch marks of genius, that he was particularly taken notice of by Queen Elizabeth when very young. He was educated at Trinity college, Cambridge; and made ſuch incredible progreſs in his ſtudies, that, before he was 16, he had not only run through the whole circle of the liberal arts as they were then taught, but began to perceive thoſe imperfections in the reigning philoſophy, which he afterwards ſo effectually expoſed, and thereby not only overturned that tyranny which prevented the progreſs of true knowledge, but laid the foundation of that free and uſeful philoſophy which has ſince opened a way to ſo many glorious diſcoveries. On his leaving the univerſity, his father ſent him to France; where, before he was 19 years of age, he wrote a general view of the ſtate of Europe: but Sir Nicholas dying, he was obliged ſuddenly to return to England; when he applied himſelf to the ſtudy of the common law, at Gray's Inn. At this period the famous earl of Eſſex, who could diſtinguiſh merit, and who paſſionately loved it, entered into an intimate friendſhip with him; zealouſly attempted, though without ſucceſs, to procure him the office of queen's ſolicitor; and, in order to comfort his friend under the diſappointment, conferred on him a preſent of land to the value of 1800l. Bacon, notwithſtanding the friendſhip of ſo great a perſon; notwithſtanding the number and power of his own relations; and, above all, notwithſtanding the early prepoſſeſſion of her majeſty in his favour; met with many obſtacles to his preferment during her reign. In particular, his enemies repreſented him as a ſpeculative man, whoſe head was filled with philoſophical notions, and therefore more likely to perplex than forward public buſineſs. It was not without great difficulty that lord treaſurer Burleigh obtained for him the reverſion of regiſter to the ſtar-chamber, worth about 1600l. a-year, which place fell to him about 20 years after. Neither did he obtain any other preferment all this reign; though if obedience to a ſovereign in what muſt be the moſt diſagreeable of all offices, viz. the caſting reflections on a deceaſed friend, entitled him, he might have claimed it. The people were ſo clamorous even againſt the queen herſelf on the death of Eſſex, that it was thought neceſſary to vindicate the conduct of the adminiſtration. This was aſſigned to Bacon, which brought on him univerſal cenſure, nay his very life was threatened. Upon the acceſſion of King James, he was ſoon raiſed to conſiderable honours; and wrote in favour of the union of the two kingdoms of Scotland and England, which the king ſo paſſionately deſired. In 1616, he was ſworn of the privy-council. He then applied himſelf to the reducing and recompoſing the laws of England. He diſtinguiſhed himſelf, when attorney-general, by his endeavours to reſtrain the cuſtom of duels, then very frequent. In 1617, he was appointed lord keeper of the great ſeal. In 1618, he was made lord chancellor of England, and created Lord Verulam. In the midſt of theſe honours and applauſes, and multiplicity of buſineſs, he forgot not his philoſophy, but in 1620 publiſhed his great work entitled *Novum Organum*. We find by ſeveral letters of his, that he thought convening of parliaments was the beſt expedient for the king and people. In 1621, he was advanced to the dignity of Viſcount St Albans, and appeared with the greateſt ſplendour at the opening of the ſeſſion of parliament. But he was ſoon after ſurpriſed with a melancholy reverſe of fortune. For, about the 12th of March, a committee of the houſe of commons was appointed to inſpect the abuſes of the courts of juſtice. The firſt thing they fell upon was bribery and corruption, of which the lord chancellor was accuſed. For that very year complaints being made to the houſe of commons of his lordſhip's having received bribes, thoſe complaints were ſent up to the houſe of lords; and new ones being daily made of a like nature, things ſoon grew

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grew too high to be got over. The king found it was impossible to save both his chancellor, who was openly accused of corruption, and Buckingham his favourite, who was secretly and therefore more dangerously attacked as the encourager of whatever was deemed most illegal and oppressive: he therefore forced the former to abandon his defence, giving him positive advice to submit himself to his peers, and promising upon his princely word to screen him in the last determination, or, if that could not be, to reward him afterwards with an ample retribution of favour. The chancellor, though he foresaw his approaching ruin if he did not plead for himself, resolved to obey; and the house of peers, on the 3d of May 1621, gave judgment against him, "That he should be fined 40,000l. and remain prisoner in the Tower during the king's pleasure; that he should for ever be incapable of any office, place, or employment, in the state or commonwealth; and that he should never sit in parliament, or come within the verge of the court." The fault which, next to his ingratitude to Essex, thus tarnished the glory of this illustrious man, is said to have principally proceeded from his indulgence to his servants, who made a corrupt use of it. One day, during his trial, passing through a room where several of his domestics were sitting, upon their rising up to salute him, he said, "Sit down, my masters; your rise hath been my fall." *Stephens*, p. 54. And we are told by Rushworth, in his historical collections, "That he treasured up nothing for himself or family, but was over-indulgent to his servants, and connived at their takings, and their ways betrayed him to that error; they were profuse and expensive, and had at their command whatever he was master of. The gifts taken were for the most part for interlocutory orders; his decrees were generally made with so much equity, that though gifts rendered him suspected for injustice, yet never any decree made by him was reversed as unjust." It was peculiar to this great man (say the authors of the Biogr. Brit.) to have nothing narrow and selfish in his composition: he gave away without concern whatever he possessed; and believing other men of the same mould, he received with as little consideration. He retired, after a short imprisonment, from the engagements of an active life, to which he had been called much against his genius, to the shade of a contemplative one, which he had always loved. The king remitted his fine, and he was summoned to parliament in the first year of King Charles I. It appears from the works composed during his retirement, that his thoughts were still free, vigorous, and noble. The last five years of his life he devoted wholly to his studies. In his recess he composed the greatest part of his English and Latin works. He expired on the 9th of April 1626; and was buried in St Michael's church at St Alban's, according to the direction of his last will, where a monument of white marble was erected to him by Sir Thomas Meautys, formerly his secretary, and afterward clerk of the privy council under two kings. A complete edition of this great man's works was published at London in the year 1740.—Addison has said of him, That he had the sound, distinct, comprehensive knowledge of Aristotle, with all the beautiful light graces and embellishments of Cicero. The honourable Mr Walpole calls him the *Prophet of Arts* which Newton was afterwards to reveal; and adds, that his genius and his works will be universally admired as long as science exists. "As long as ingratitude and adulation are despicable, so long shall we lament the depravity of this great man's heart. Alas! that he who could command immortal fame, should have stooped to the little ambition of power."

Bacon || Bactria.

Bacon, *Sir Nathaniel*, knight of the bath, and an excellent painter, was a younger son of the lord keeper, and half brother to the great Sir Francis. He travelled into Italy, and studied painting there; but his manner and colouring approaches nearer to the style of the Flemish school. Mr Walpole observes, that at Culford, where he lived, are preserved some of his works; and at Gorhambury, his father's seat, is a large picture by him in oil, of a cook-maid with a dead fowl, admirably painted, with great nature, neatness, and lustre of colouring. In the same house is a whole length of him, by himself, drawing on a paper, his sword and pallet hung up, and a half length of his mother by him.

BACONTHORP, John, called the *resolute doctor*, a learned monk, was born towards the end of the 13th century at Baconthorp, a village in Norfolk. He spent the early part of his life in the convent of Blackney, near Walsingham in the same county; whence he removed to Oxford, and from thence to Paris; where being distinguished for his learning, he obtained degrees in divinity and laws, and was esteemed the principal of the Averroists *. In 1329 he returned to England, and was immediately chosen twelfth provincial of the English Carmelites. In 1333 he was sent for to Rome; where, we are told, he first maintained the pope's sovereign authority in cases of divorce, but that he afterward retracted his opinion. He died in London in the year 1346. Leland, Bale, and Pits, unanimously gave him the character of a monk of genius and learning. He wrote, 1. *Commentaria seu questiones super quatuor libros sententiarum*; and, 2. *Compendium legis Christi, et quodlibeta*; both which underwent several editions at Paris, Milan, and Cremona. Leland, Bale, and Pits, mention a number of his works never published.

* See *Averroes*.

BACTRIA, or Bactriana, now *Chorassan* or *Khorasan*, an ancient kingdom of Asia, bounded on the west by Margiana, on the north by the river Oxus, on the south by Mount Paropismus, and on the east by the Asiatic Scythia and the country of the Massagetæ. It was a large, fruitful, and well-peopled country, containing according to Ammianus Marcellinus 1000 cities, though of these only a few are particularly mentioned by historians, of which that formerly called *Maracanda*, now *Samarcand*, is the most considerable.

Of the history of this country we know but little. Authors agree that it was subdued first by the Assyrians, afterwards by Cyrus, and then by Alexander the Great. Afterwards it remained subject to Seleucus Nicator and his successors till the time of Antiochus Theos; when Theodorus, from governor of that province, became king, and strengthened himself so effectually in his kingdom, while Antiochus was engaged in a war with Ptolemy Philadelphus king of Egypt, that he could never afterwards dispossess him of his acquisitions. His posterity continued to enjoy the kingdom

dom for some time, till they were driven out by the Scythians, who reigned in Bactria at the time of Adrian, Antoninus Pius, &c. The Scythians were in their turn driven out by the Huns or Turks, and these often conquered by the Saracens and Tartars; nevertheless they continued in possession of this country in the time of Ladislaus IV. king of Hungary.

In early times the Bactrians differed little in their manners from the Nomades; and be ingnear neighbours of the Scythians, who were a very warlike people, the Bactrian soldiers were reckoned the best in the world. Their appearance was very savage; being of an enormous stature, having a terrible aspect, rough beards, and long hair hanging down their shoulders. Some authors assert that they kept dogs on purpose to devour such as arrived at extreme old age, or who were exhausted by long sickness. They add, that for all their fierceness, the Bactrian husbands were such dupes to their wives, that they durst not complain of them even for conjugal infidelity, to which it seems the latter were very much addicted.

BACTROPERATA, an ancient appellation given to philosophers by way of contempt, denoting a man with a staff and a budget.

We suppose it is of the same people that Pauchasias Radbertus speaks under the corrupt name of *Bacoperitæ* or *Bacchionitæ*, whom he described as philosophers who had so great a contempt for all earthly things, that they kept nothing but a dish to drink out of; and that one of this order seeing a peasant scooping up the water in his hand, threw away his cup as a superfluity: which is nothing but the old story of Diogenes the Cynic.

BACCULE, in *Fortification*, a kind of portcullis, or gate, made like a pit-fall with a counterpoise, and supported by two great stakes. It is usually made before the corpade-guard, not far from the gate of a place.

BACULOMETRY, the art of measuring accessible or inaccessible heights, by the help of one or more baculi, staves, or rods. See GEOMETRY.

BACURIUS, or BATURIUS, king of the Iberians, a people on the side of the Caspian sea. One day being a-hunting, he lost sight of his company, through a great storm and sudden darkness; upon which he vowed to the God of his Christian slave, that if he were delivered he would worship him alone: the day breaking up immediately, he made good his promise, and became the apostle of his country.

BADAGSHAN, a very ancient city of Great Bukharia, in the province of Balkh, situated at the foot of those high mountains which separate Indostan from Great Tartary. The city is exceedingly strong by its situation; and belongs to the khan of Proper Bukharia, who uses it as a kind of state-prison to secure those he is jealous of. The town is not large, but well built, and very populous. It stands on the north side of the river Amu, about 100 miles from its source, and is a great thoroughfare for the caravans travelling to Little Bukharia. The inhabitants are enriched by mines of gold, silver, and rubies, which are in the neighbourhood; and those who live at the foot of the mountains gather a great quantity of gold and silver dust brought down in the spring by torrents occasioned by the melting of the snow on the top.

BADAJOZ, a large and strong town, capital of Estremadura in Spain. It is seated on the river Guadiana, over which there is a fine bridge built by the Romans. On this bridge the Portuguese were defeated in 1661, by Don John of Austria. The population of Badajoz is computed at near 9,000 inhabitants, but a small number in proportion to its extent. Most of the streets are extremely narrow, and the houses small and crowded. W. Long. 7. 3. N. Lat. 38. 35.

BADELONA, a town of Catalonia in Spain, seated on the Mediterranean. Lord Peterborough landed here in 1704, when, with Charles then king of Spain, he laid siege to Barcelona, from which it is ten miles distant. E. Long. 2. 20. N. Lat. 41. 12.

BADEN, the district of, in Swisserland, has three cities, Baden, Keifers Stoul, and Klingnaw, besides a town that passes for a city, named *Zurzach*. It is one of the finest countries in Swisserland; and is watered with three navigable rivers, the Limmet, Russ, and Are. The land is fertile in corn and fruit, and there are places on the sides of the Limmet which produce wine. It maintains a communication between the cantons of Zurich and Bern, being seated between their north extremities. It extends on one side to the Are, as far as the place where it falls into the Rhine, and on the other side beyond the Rhine, where there are some villages which depend thereon. Most of the inhabitants are Papists. By the treaty of peace at the conclusion of the war which broke out in 1712 between the Protestant and Popish cantons, this country was yielded to the Protestant cantons of Zurich and Bern. Before, it was the property of the eight old cantons; however, as the canton of Glaris had taken no part in this war, by the consent of both parties its right was still continued.

BADEN, the capital of the above district, is an agreeable city, moderately large, seated on the side of the Limmet, in a plain flanked by two high hills, between which the river runs. This city owes its rise to its baths, which were famous before the Christian era. Several monuments of antiquity have been found here from time to time, particularly in 1240. When they were opening the large spring of the baths, they found statues of several heathen gods, made of alabaster; Roman coins, made of bronze, of Augustus, Vespasian, Decius, &c.; and several medals of the Roman emperors, of gold, silver, copper, and bronze. There are two churches in Baden; one of which is collegiate, and makes a good appearance; the other is a monastery of the Capuchins, near the townhouse. This last building serves not only for the assemblies of their own council, but also for those of the cantons. The diet assembles there in a handsome room made for that purpose; the deputies of Zurich sit at the bottom behind a table, as the most honourable place; the ambassadors of foreign powers are seated on one side to the right, and the deputies of the other cantons are ranged on each side the room. The bailiff of Baden resides in a castle at the end of a handsome wooden bridge, which is covered in. Before this castle there is a stone pillar, erected in honour of the emperor Trajan, who paved a road in this country 85 Italian miles in length. The inhabitants are rigid Roman catholics, and formerly behaved in a most insolent manner to the Protestants, but they are now obliged by their masters to be more ſubmiſſive. The baths which are on each ſide of the river are a quarter of a league from the city. Joining to the ſmall baths there is a village, and to the large a town which may paſs for a ſecond Baden. It is ſeated on a hill, of which the aſcent is ſteep. There the baths are brought into inns and private houſes, by means of pipes, which are about 60 in all. There are alſo public baths in the middle of the towns, from a ſpring which riſes in the ſtreet, where the poor bathe *gratis*, but they are expoſed quite naked to all that paſs by. All the baths are hot, and one to ſo great a degree as to ſcald the hand; and they are impregnated with a great deal of ſulphur, with ſome alum and nitre. They are uſeful for drinking as well as bathing; and are ſaid to cure all diſeaſes from a cold cauſe, head-aches, vertigoes, &c. They ſtrengthen the ſenſes, cure diſeaſes of the breaſt and bowels, aſthmas, and obſtructions. They are peculiarly excellent for women's diſeaſes. E. Long. 8. 25. N. Lat. 47. 27.

Baden, the Margravate of, in the circle of Swabia, in Germany, is bounded by the Palatinate of the Rhine, on the north; by the Black Foreſt, on the eaſt; by Switzerland, on the ſouth; and by the Rhine, which divides it from Alſace, on the eaſt: and is about 90 miles in length, from north to ſouth; but not above 20 in breadth, where it is wideſt. It is a very populous and fruitful country, abounding in corn and wine. Veniſon and wild fowl are ſo plentiful, that they are the common diet of the peaſants. The rivers that water this territory, are the Rhine, Ens, Wirmbs, and Phints, which yield plenty of fiſh. They feed their hogs with cheſnuts, which make the bacon excellent. They have free-ſtone for building, and marble of all colours. They have ſome agate, and great quantities of hemp and flax for exportation. The chief towns are Baden, Durlach, Stolhafen, Raſtadt, Gerſbach, Pforſheim, and Hochberg.

Baden, the chief city of the above margravate, has a caſtle that ſtands on the top of a hill, which is the reſidence of a prince. The town is ſeated among hills, on rocky and uneven ground, which renders the ſtreets inconvenient and crooked. It is famous for its baths, the ſprings of which are ſaid to be above 300. Some of them are hot, and accounted to be very good in nervous caſes. They partake of ſalt, alum, and ſulphur. E. Long. 9. 24. N. Lat. 48. 50.

Baden, a town of Germany, in the archduchy of Auſtria, ſeated on the Little Suechat, is a neat little walled town, ſtanding in a plain not far from a ridge of hills which run out from the mountain Cetius. It is much frequented by the people of Vienna, and the neighbouring parts, on account of its baths. The ſprings ſupply two convenient baths within the town, five without the walls, and one beyond the river. They are good for diſtempers of the head, the gout, dropſy, and moſt chronic diſeaſes. E. Long. 17. 10. N. Lat. 48. 0.

BADENOCH, the moſt eaſterly part of Invernefsſhire, in Scotland, extending about 33 miles in length from eaſt to weſt, and 27 from north-eaſt to ſouth-weſt where broadeſt. It has no conſiderable town, and is very barren and hilly, but abounds with deer, and other kinds of game.

BADEN-weiller, a town of Germany, belonging to the lower margravate of Baden. E. Long. 7. 50. N. Lat. 47. 55.

BADENS, Francis, hiſtorical and portrait painter, was born at Antwerp in 1571; and the firſt rudiments of the art were communicated to him by his father, who was but an ordinary artiſt. However, he viſited Rome, and ſeveral parts of Italy, and then formed a good taſte of deſign, and a manner exceedingly pleaſing. When he returned to his own country his merit procured for him great employment, and ſtill greater reputation, and he was uſually diſtinguiſhed by the name of the Italian painter. His touch was light and ſpirited, and his colouring warm; and he had the honour of being the firſt who introduced a good taſte of colouring among his countrymen. While his acknowledged merit was rewarded with every public teſtimony of eſteem and applauſe, unhappily he received an account of the death of his brother, who had been aſſaſſinated on a journey; and the intelligence affected him ſo violently, that it occaſioned his own death, to the inexpreſſible regret of every lover of the art, in 1603.

BADGE, in naval architecture, ſignifies a ſort of ornament placed on the outſide of ſmall ſhips, very near the ſtern, containing either a window for the convenience of the cabin, or a repreſentation of it. It is commonly decorated with marine figures, martial inſtruments, or ſuch like emblems.

BADGER, in *Zoology*, the Engliſh name of a ſpecies of urſus. See Ursus.

Badger, in old law-books, one that was licenſed to buy corn in one place and carry it to another to ſell, without incurring the puniſhment of an engroſſer.

BADIA, an ancient town of Bætica, on the Anas; now ſuppoſed to be Badajoz on the Guadiana.

BADIAGA, in the *materia medica* the name of a ſort of ſpongy plant, common in the ſhops in Moſcow, and ſome other northern kingdoms. The uſe of it is the taking away of livid marks from blows and bruiſes, which the powder of this plant is ſaid to do in a night's time.

BADIANE, or Bandian, the ſeed of a tree which grows in China, and ſmells like aniſe-ſeed. The Chineſe, and the Dutch in imitation of them, ſometimes uſe the badiane to give their tea an aromatic taſte.

BADIGEON, a mixture of plaſter and free-ſtone, well ground together, and ſifted; uſed by ſtatuaries to fill up the little holes, and repair the defects in ſtones, whereof they make their ſtatues and other work.

The ſame term is alſo uſed by joiners for ſaw-duſt mixed with ſtrong glue, wherewith they fill up the chaps and other defects in wood after it is wrought.

BADILE, Antonio, hiſtory and portrait painter, was born at Verona in 1480, and by great ſtudy and application acquired a more extenſive knowledge of the true principles of painting than any of his predeceſſors. He was confeſſedly a moſt eminent artiſt; but he derived greater honour from having two ſuch diſciples as Paolo Veroneſe and Baptiſta Zelotti, than he did even from the excellence of his own compoſitions. He died in 1560. His colouring was admirably good; his carnations beautiful; and his portraits preſerved the perfect reſemblance of fleſh and real life: nor had he any cauſe to envy the acknowledged merit of Titian, Giorgione, or the best of his cotemporaries.

BADIS, a fortress of Livonia, subject to Russia. E. Long. 23. 10. N. Lat. 59. 15.

BADIUS, Conrad, and Stephen Robert, his brother; French refugees; celebrated as printers at Geneva, and Conrad as an author. The latter died in 1566.

BÆCKEA. See Botany *Index*.

BÆTERRÆ, an ancient town of the Tertosages in Gallia Narbonensis; now *Besiers*, on the east bank of the Obris, now *Orbis* or *Orbe*, in Lower Languedoc.

BÆTICA, a province of ancient Spain, so called from the famed river Bætis, afterwards *Tartessus*, now *Guadalquiver*, or the great river. It was bounded on the west by Lusitania; on the south, by the Mediterranean, and Sinus Gaditanus; on the north by the Cantabric sea, now the bay of Biscay. On the east and north-east, its limits cannot be so well ascertained as they are very reasonably thought to have been in a continual state of fluctuation, as each petty monarch had an opportunity of encroaching upon his neighbour. The province was divided in two by the river Bætis already mentioned. On the one side of which, towards the Anas, were situated the Turdetani, from whence the kingdom was called *Turdetania*, though more generally known by the name of *Bæturia*. On the other side were situated the Bastuli, Bastetani, and Contestani, along the Mediterranean coasts. The Bastuli were supposed to be of Phœnician extract, and dwelt along the coasts of the Mediterranean, till, driven from thence by the Moors, they fled into the mountainous parts of Galicia, which they then called from their own name *Bastulia*. The Bastetani were seated higher up, on the same coasts. The territories of both these made part of what has since become the kingdom of *Granada;* in which there is a ridge of very high mountains, called from the above-mentioned people, the *Bastetanian mountains*. Mention is also made of their capital Batestana; a place of such strength, that King Ferdinand was six months besieging it before he could take it from the Moors. The whole province of Bætica, according to the most probable account, contained what is now called *Andalusia*, part of the kingdom of Granada, and the outward boundaries of Estremadura.

BÆTIS. See Bætica.

BÆTULO, a town of ancient Spain in the Terraconensis; now *Badelona* in Catalonia.

BÆTYLIA, anointed stones, worshipped by the Phœnicians, by the Greeks before the time of Cecrops, and by other barbarous nations. They were commonly of a black colour, and consecrated to some god, as Saturn, Jupiter, the Sun, &c. Some are of opinion that the true original of these idols is to be derived from the pillar of stone which Jacob erected at Bethel, and which was afterwards worshipped by the Jews.

These *bætylia* were much the object of the veneration of the ancient heathens. Many of their idols were no other. In reality, no sort of idol was more common in the eastern countries, than that of oblong stones erected, and hence termed by the Greeks, *κιονες*, *pillars*. In some parts of Egypt they were planted on both sides of the highways. In the temple of Heliogabalus, in Syria, there was one pretended to have fallen from heaven. There was also a famous black stone in Phrygia, said to have fallen from heaven. The Romans sent for it and the priests belonging to it with much ceremony, Scipio Nasica being at the head of the embassy.

BÆZA, a city of Andalusia in Spain, seated on a high hill three miles from the Guadalquiver; it is the see of a bishop, and has a kind of university founded by John d'Avila. It was taken from the Moors about the end of the 15th century. E. Long. 3. 15. N. Lat. 37. 45.

BAFFETAS, or Bastas, a cloth made of coarse white cotton thread, which comes from the East Indies. That of Surat is the best.

BAFFIN's bay, a gulf of North America, running north-east from Cape Farewell in West Greenland, from 6° to 8° of north latitude.

BAFFO, a considerable town in the island of Cyprus, with a fort built near ancient Paphos, of which some considerable ruins yet remain, particularly some broken columns, which probably belonged to the temple of Venus. E. Long. 32. 20. N. Lat. 34. 50.

BAG, in *Commerce*, a term signifying a certain quantity of some particular commodity: a bag of almonds, for instance, is about 300 weight; of anise-seeds, from 300 to 400, &c.

Bags, are used in most countries to put several sorts of coin, either of gold, silver, brass, or copper. Bankers, and others, who deal much in current cash, label their bags of money, by tying a ticket or note at the mouth of the bag, signifying the coin therein contained, the sum total, its weight, and of whom it was received. Tare is allowed for the bag.

Bag, among *Farriers*, is when, in order to retrieve a horse's lost appetite, they put in an ounce of asafœtida, and as much powder of savin, into a bag, to be tied to the bit, keeping him bridled for two hours, several times a-day; as soon as the bag is taken off he will fall to eating. The same bag will serve a long time.

BAGAMADER, or Bagamedri, a province of the kingdom of Abyssinia in Africa. It is said to receive its name from the great number of sheep bred in it; *meder* signifying land or earth, and *bag* a sheep. Its length is estimated about 60 leagues, and its breadth 20: but formerly it was much more extensive; several of its provinces having been dismembered from it, and joined to that of Tigre. A great part of it, especially towards the east, is inhabited by wandering Gallas and Caffres.

BAGAUDÆ, or Bacaudæ, an ancient faction of peasants, or malecontents, who ravaged Gaul. The Gauls being oppressed with taxes, rose about the year of Christ 290, under the command of Amand and Elian; and assumed the name *bagaudæ*, which, according, to some authors, signified in the Gallic language *forced rebels;* according to others, *tribute;* according to others, *robbers;* which last signification others allow the word had, but then it was only after the time of the *bagaudæ*, and doubtless took its rise from them.

BAGDAD, a celebrated city of Asia in Irak Arabia, seated on the eastern barks of the Tigris, in E. Long. 43 40. N. Lat. 33. 15. By many authors this city is very

Bagdad. very improperly called *Babylon*. The latter ſtood on the Euphrates at a conſiderable diſtance.

This city, for many years the capital of the Saracen empire, was founded by the caliph Al Manſur, the ſecond of the houſe of Al Abbas, after an attempt by the Rawandians to aſſaſſinate him, as already mentioned. See ARABIA, N° 184.

1 Why the city was built.

The reaſons aſſigned by the Arabian hiſtorians for building the city of Bagdad are, That the above-mentioned attempt to aſſaſſinate the caliph had diſguſted him at his Arabian ſubjects in general, and that the ſpot where Bagdad ſtood was at a conſiderable diſtance from the city of Cufa particularly; the inhabitants of which were remarkable for their treachery and inconſtancy, Al Manſur himſelf having felt ſeveral inſtances of it. Beſides the people of Irac, who had always continued faithful to him, repreſented, that by building his capital near the confluence of the Euphrates and Tigris, it would be in a great meaſure ſecured from the inſults and attacks of thoſe who ſhould have an inclination to diſpute the caliphate with him; and that by being ſituated as it were in the middle of the tract comprehending the diſtricts of Baſrah, Cufa, Waſet, Mawſel, and Swada, at no great diſtance from theſe cities, it would be plentifully ſupplied with proviſions by means of the aforeſaid rivers.

2 Ancient city deſcribed.

Concerning the origin of the name *Bagdad*, there are various accounts, which, being equally uncertain and trifling, merit no attention. The firſt city that went by this name was ſituated on the weſtern bank of the Tigris; from whence Al Manſur deſpatched his ſon Al Mohdi with a body of Moſlem troops to the oppoſite bank. Here the young prince took poſt, and fortified the place on which he had encamped with a wall, in order to cover his troops, as well as the workmen employed by his father on the other ſide of the river, from the incurſions of the Perſians, who ſeemed to have taken umbrage at the erection of a new metropolis ſo near the frontiers of their dominions. Hence that part of the city ſoon after built on the eaſtern banks of the Tigris, received the name of the *Camp* or *Fortreſs of Al Mohdi*. The caliph had a ſuperb and magnificent palace both in the eaſtern and weſtern part of the town. The eaſtern palace was ſurrounded on the land ſide by a ſemicircular wall that had ſix gates; the principal of which ſeems to have been called *the gate of prefects*, whoſe entrance was generally kiſſed by the princes and ambaſſadors that came to the caliph's court. The weſtern part of the city was entirely round, with the caliph's palace in the centre, and having the great moſque annexed to it. The eaſtern part conſiſted of an interior and exterior town, each of which was ſurrounded by a wall. For ſome time the building of the city went but ſlowly on, owing to a ſcarcity of materials for building; for which reaſon the caliph was ſometimes inclined to remove the materials of Al Madayen, the ancient metropolis of the Perſian empire. But, upon trial, he found the ſtones to be of ſuch immenſe ſize, that the removal of them to Bagdad would be attended with great difficulty and expence; beſides, he conſidered that it would be a reflection upon himſelf to have it ſaid that he could not finiſh his metropolis without deſtroying ſuch a pile of building as perhaps could not be paralleled in the whole world; for which reaſons he at length gave over his deſign, and erected the city of Bagdad moſt probably out of the ruins of the ancient cities of Seleucia and Cteſiphon, putting an end to his undertaking in the 149th year of the Hegira, or four years after the city was begun. Bagdad.

From the building of the city of Bagdad to the death of Al Manſur nothing very remarkable happened, excepting ſome irruptions made into the territories of the Greeks, and by the Arabs into ſome of the caliph's other territories. In the 157th year of the Hegira alſo, a grievous famine was felt in Meſopotamia, which was quickly after followed by a plague that deſtroyed great numbers. This year likewiſe, the Chriſtians, who had been all along very ſeverely dealt with by Al Manſur, were treated with the utmoſt rigour by Muſa Ebn Moſaab the caliph's governor; every one who was unable to pay the enormous tribute exacted of them being thrown into priſon without diſtinction.

3 Death of Al Manſur.

The next year, being the 158th of the Hegira, the caliph ſet out from Bagdad, in order to perform the pilgrimage to Mecca: but being taken ill on the road, he expired at Bir Maimun, whence his body was carried to Mecca; where, after a hundred graves had been dug, that his ſepulchre might be concealed, he was interred, having lived according to ſome 63, according to others 68 years, and reigned 22. He is ſaid to have been extremely covetous, and to have left in his treaſury 600,000,000 dirhems, and 24,000,000 dinars. He is reported to have paid his cook by aſſigning him the heads and legs of the animals dreſſed in his kitchen, and to have obliged him to procure at his own expence all the fuel and veſſels he had occaſion for.

4 Succeeded by Al Mohdi.

When Al Manſur expired at Bir Maimun, he had only his domeſtics and Rabi his freedman with him. The latter of theſe, for ſome time, kept his death concealed, and pretended to have a conference with him, in which, as he gave out, the caliph commanded him to exact an oath of allegiance to Al Mohdi his ſon, as his immediate ſucceſſor, and to Iſa Ebn Muſa his couſin-german, as the next apparent heir to the crown. He then deſpatched a courier to Bagdad with the news of Al Manſur's death; upon which Al Mohdi was unanimouſly proclaimed caliph. Iſa Ebn Muſa, however, no ſooner heard this news, than he began to entertain thoughts of ſetting up for himſelf at Cufa, where he then reſided; and in order to facilitate the execution of his ſcheme, fortified himſelf in that city. But Al Mohdi being appriſed of his defection, ſent a detachment of 1000 horſe to bring him to Bagdad; which being done, Al Mohdi not only prevailed upon him to own his allegiance to him, but alſo to give up his right to the ſucceſſion for 10,000 according to ſome, or according to others for 10,000,000, dinars.

5 Rebellion of Al Mokanna.

From the acceſſion of Al Mohdi to the 146th year of the Hegira, the moſt remarkable event was the rebellion of Al Mokanna. This impious impoſtor, whoſe true name was *Hakem Ebn Heſham*, came originally from Khoraſan, and had been an under ſecretary to Abu Moſlem governor of that province. He afterwards turned ſoldier, and paſſed thence into Mawaralnahr, where he gave himſelf out for a prophet. The name of Al Mokanna, as alſo that of Al Borkai, that is, the *veiled*, he took from his cuſtom of covering his face with a veil or girdle maſk, to conceal his deformity; he having loſt an eye in the wars, and being otherwiſe

otherwise of a despicable appearance; though his followers pretended he did this for the same reason that Moses did, viz. lest the splendour of his countenance should dazzle the eyes of his beholders. In some places he made a great many proselytes, deluding the people with a number of juggling tricks which they swallowed as miracles, and particularly by causing the appearance of a moon to rise out of a well for many nights together; whence he was also called in the Persian tongue, *Sazendeh mah*, or the *moon-maker*. This wretch, not content with being reckoned a prophet, arrogated to himself divine honours; pretending that the Deity resided in his person, having proceeded to him from Abu Moslem, in whom he had taken up his residence before. At last this impostor raised an open rebellion against the caliph, and made himself master of several fortified places in Khorasan, so that Al Mohdi was obliged to send one of his generals with an army against him. Upon the approach of the caliph's troops, Al Mokanna retired into one of his strong fortresses which he had well provided for a siege; and sent his emissaries abroad to persuade the people that

6 Dreadful catastrophe of him and all his family.

he raised the dead to life, and foretold future events. But being closely besieged by the caliph's forces, and seeing no possibility of escaping, he gave poison in wine to his whole family and all that were with him, in the castle; when they were dead, he burnt their bodies, together with all their furniture, provisions, and cattle; and lastly, he threw himself into the flames, or, as others say, into a tub of aquafortis, or some other preparation, which consumed every part of him except the hair. When the besiegers therefore entered the place, they found no living creature in it, except one of Al Mokanna's concubines, who, suspecting his design, had hid herself, and now discovered the whole matter. This terrible contrivance, however, failed not to produce the desired effect. He had promised his followers, that his soul should transmigrate into the form of an old man riding on a greyish coloured beast, and that after so many years he would return and give them the earth for their possession; which ridiculous expectation kept the sect in being for several years.

7 Harun Al Raschid's success against the Greeks.

All this time war had been carried on with the Greeks, but without any remarkable success on either side. In the 164th year of the Hegira, however, Al-Mohdi ordered his son Harun Al Raschid to penetrate into the Greek territories with an army of 95,000 men. Harun, then, having entered the dominions of the empress Irene, defeated one of her commanders that advanced against him; after which he laid waste several of the imperial provinces with fire and sword, and even threatened the city of Constantinople itself. By this the empress was so terrified, that she purchased a peace with the caliph by paying him an annual tribute of 70,000 pieces of gold; which, for the present at least, delivered her from the depredations of these barbarians. After the signing of the treaty, Harun returned

8 Unaccountable darkness.

home laden with spoils and glory. This year, according to some of the oriental historians, the sun one day, a little after his rising, totally lost his light in a moment, without being eclipsed, when neither any fog nor any cloud of dust appeared to obscure him. This frightful darkness continued till noon, to the great astonishment of the people settled in the countries where it happened.

9 Al Mohdi poisoned;

In the 169th year of the Hegira, Al Mohdi was poisoned, though undesignedly, by one of his concubines named *Hasanah*. She had designed to destroy one of her rivals whom she imagined to have too great an ascendant over the caliph by giving her a poisoned pear. This the latter, not suspecting any thing, gave to the caliph; who had no sooner eaten it than he felt himself in exquisite torture, and soon after expired.

10 as likewise his successor Al Hadi.

On the death of Al Mohdi, he was succeeded by his eldest son Al Hadi; who having formed a design to deprive his younger brother Harun Al Raschid of his right of succession, and even to assassinate him, was poisoned by his vizier in the 170th year of the Hegira; and on his death the celebrated caliph Harun Al Rashid ascended the throne.

11 Harun Al Rashid caliph.

This was one of the best and wisest princes that ever sat on the throne of Bagdad. He was also extremely fortunate in all his undertakings, though he did not much extend his dominions by conquest. In his time the Moslem empire may be said to have been in its most flourishing state, though by the independency of the Moslems in Spain, who had formerly set up a caliph of the house of Ommiyah, his territories were not quite so extensive as those of some of his predecessors. He possessed the provinces of Syria, Palestine,

12 Extent of his empire.

Arabia, Persia, Armenia, Natolia, Media or *Aderbijan*, Babylonia, Assyria, Sindia, Sijistan, Khorasan, Tabrestan, Jorjan, Zablestan or *Sablestan*, Mawaralnahr or *Great Bukharia*, Egypt, Libya, Mauritania, &c.; so that his empire was by far the most powerful of any in the world, and extended farther than the Roman empire ever had done.

13 He finds a ring he had thrown into the Tigris.

The first instance of Harun's good fortune, and which was taken for a presage of a prosperous and happy reign, was his finding a valuable ring which he had thrown into the Tigris to avoid being deprived of it by his brother Al Hadi. He was able to give the divers no other direction than by throwing a stone from the bridge of Bagdad, about the same place of the river in which he had thrown the ring; notwithstanding which, they found it without any great difficulty.

14 Divides the empire among his sons, and settles the succession.

In the 186th year of the Hegira, beginning January 10. 802, the caliph divided the government of his extensive dominions among his three sons, in the following manner: To Al Amin the eldest, he assigned the provinces of Syria, Irak, the three Arabias, Mesopotamia, Assyria, Media, Palestine, Egypt, and all that part of Africa extending from the confines of Egypt and Ethiopia to the straits of Gibraltar, with the dignity of caliph; to Al Mamun the second, he assigned Persia, Kerman, the Indies, Khorasan, Tabrestan, Cablestan, and Zablestan, together with the vast province of Mawaralnahr; and to this third son Al Kasem, he gave Armenia, Natolia, Jorjan, Georgia, Circassia, and all the Moslem territories bordering upon the Euxine sea. As to the order of succession, Al Amin was to ascend the throne immediately after his father's decease; after him, Al Mamun; and then Al Kasem, whom he had surnamed *Al Mutaman*.

The most considerable exploit performed by this caliph

15 His ſucceſsful wars with the Greeks.

caliph were againſt the Greeks, who by their perfidy provoked him to make war upon them, and whom he always overcame. In the 187th year of the Hegira, the caliph received a letter from the Greek emperor Nicephorus ſoon after he had been advanced to the imperial dignity, commanding him to return all the money he had extorted from the empreſs Irene, though that had been ſecured to him by the laſt treaty concluded with that princeſs, or expect ſoon to ſee an imperial army in the heart of his territories. This inſolent letter ſo exaſperated Harun, that he immediately aſſembled his forces and advanced to Heraclea, laying the country through which he paſſed waſte with fire and ſword. For ſome time alſo he kept that city ſtraitly beſieged; which ſo terrified the Greek emperor, that he ſubmitted to pay an annual tribute. Upon this Harun granted him a peace, and returned with his army. But a hard froſt ſoon after happening in theſe parts, Nicephorus took for granted that Al Raſhid would not pay him another viſit, and therefore broke the treaty he had concluded. Of this the caliph receiving advice, he inſtantly put himſelf in motion; and, notwithſtanding the inclemency of the weather, forced the emperor to accept of the terms propoſed. According to a Perſian hiſtorian, before the hoſtilities at this time commenced, Nicephorus made the caliph a preſent of ſeveral fine ſwords, giving him thereby plainly to underſtand that he was more inclinable to come to blows than to make peace with him. All theſe ſwords Harun cut aſunder with his famous ſword *Samſamah*, as if they had been ſo many radiſhes, after which ſevere proof there did not appear the leaſt flaw in the blade; a clear proof of the goodneſs of the ſword, as the cutting the others with it was of the ſtrength of Harun's arm. This ſword had fallen into Al Raſhid's hands among the ſpoils of Ebn Dakikan, one of the laſt Hamyaritic princes of Yaman; but is ſaid to have belonged originally to a valiant Arab named *Amru Ebn Maadi Carb*, by whoſe name it generally went among the Moſlems. This man is ſaid to have performed very extraordinary feats with his ſword, which induced a certain prince to borrow it from him; but he not being able to perform any thing remarkable with it, complained to Amru that it had not the deſired effect: upon which that brave man took the liberty to tell him, that he had not ſent him his arm along with his ſword.

In the 188th year of the Hegira, war was renewed with the Greeks, and Nicephorus with a great army attacked the caliph's forces with the utmoſt fury. He was, however, defeated with the loſs of 40,000 men, and received three wounds in the action; after which the Moſlems committed terrible ravages in his territories, and returned home laden with ſpoils. The next year Harun invaded Phrygia; defeated an imperial army ſent to oppoſe him; and having ravaged the country, returned without any conſiderable loſs. In the 190th year of the Hegira, commencing November 27. 805, the caliph marched into the imperial territories with an army of 135,000 men, beſides a great number of volunteers and others who were not enrolled among his troops. He firſt took the city of Heraclea, from whence he is ſaid to have carried 16,000 priſoners; after which he made himſelf maſter of ſeveral other places: and in the concluſion of the expedition, he made a deſcent on the iſland of Cyprus, which he plundered in a terrible manner. This ſucceſs ſo intimidated Nicephorus, that he immediately ſent the tribute due to Harun, the withholding of which had been the cauſe of the war, and concluded a peace upon the caliph's own terms; one of which was, that the city of Heraclea ſhould never be rebuilt. This perhaps Harun would not have ſo readily granted, had not one 16
Rebellion in Khoraſan.
Rafe Ebn Al Leith revolted againſt him at Samarcand, and aſſembled a conſiderable force to ſupport him in his defection.

The next year being the 191ſt of the Hegira, the caliph removed the governor of Khoraſan from his employment, becauſe he had not been ſufficiently attentive to the motions of the rebel Rafe Ebn Al Leith. As this governor had alſo tyrannized over his ſubjects in the moſt cruel manner, his ſucceſſor no ſooner arrived than he ſent him in chains to the caliph; but notwithſtanding all Harun's care, the rebels made this year a great progreſs in the conqueſt of Khoraſan.

Next year the caliph found it neceſſary to march in perſon againſt the rebels, who were daily becoming more formidable. The general rendezvous of his troops was in the plains of Rakka, from whence he advanced at the head of them to Bagdad. Having at that place ſupplied the troops with every thing neceſſary, he continued his march to the frontiers of Jorjan, where he was ſeized with an illneſs which grew more violent after he had entered that province. Finding himſelf therefore unable to purſue his journey, he reſigned the command of the army to his ſon Al Mamun, retiring him- 17
The caliph's death predicted by a dream.
ſelf to Tus in Khoraſan. We are told by Khondemir, that, before the caliph departed from Rakka, he had a dream, wherein he ſaw a hand over his head full of red earth, and at the ſame time heard a perſon pronouncing theſe words, "See the earth where Harun is to be buried." Upon this he demanded where he was to be buried; and was inſtantly anſwered, "At Tus." This dream greatly diſcompoſing him, he communicated it to his chief phyſician, who endeavoured to divert him, telling the caliph that the dream had been occaſioned by the thoughts of his expedition againſt the rebels. He therefore adviſed him to purſue ſome favourite diverſion that might draw his attention another way. The caliph accordingly, by his phyſician's advice, prepared a magnificent regale for his courtiers, which laſted ſeveral days. After this, he put himſelf at the head of his forces, and advanced to the confines of Jorjan, where he was attacked by the diſtemper that proved fatal to him. As his diſorder increaſed, he found himſelf obliged to retire to Tus; where being arrived, he ſent for his phyſician, and ſaid to him, "Gabriel, do you remember my dream at Rakka? we are now arrived at Tus, the place, according to what was predicted in that dream, of my interment. Send one of my eunuchs to fetch me a handful of earth in the neighbourhood of this city." Upon this, *Maſrur*, one of his favourite eunuchs, was deſpatched to bring a little of the ſoil of the place to the caliph. He ſoon returned and brought a handful of red earth, which he preſented to the caliph with his arm half bare. At the ſight of this Harun inſtantly cried out, "In truth this is the earth, and this the very arm, that I ſaw in my dream. His ſpirits immediately failing, and his malady being greatly increaſed by the perturbation of mind enſuing

upon

Bagdad. upon this sight, he died three days after, and was buried in the same place. According to Abul Faraj, Bashir Ebn Al Leith the arch-rebel's brother was brought in chains to the caliph, who was then at the point of death. At the sight of whom Harun declared, that if he could speak only two words he would say *kill him;* and immediately ordered him to be cut to pieces in his presence. This being done, the caliph soon after expired, in the year of the Hegira 193, having reigned 23 years. The distemper that put an end to his days is said to have been the bloody-flux.

18 He dies according to the prediction.

19 Succeeded by his son Al Amin.

Upon the arrival of a courier from Tus, with the news of Al Rashid's death, his son Al Amin was immediately proclaimed caliph; and was no sooner seated on the throne, than he formed a design of excluding his brother Al Mamun from the succession. Accordingly he deprived him of the furniture of the imperial palace of Khorasan; and in open violation of his father's will, who had bestowed on Al Mamun the perpetual government of Khorasan, and of all the troops in that province, he ordered these forces to march directly to Bagdad. Upon the arrival of this order, Al Mamun expostulated with the general Al Fadl Ebn Rabbi who commanded his troops, and endeavoured to prevent his marching to Bagdad; but without effect, for he punctually obeyed the orders sent by the caliph. Al Mamun, however, took care not to be wanting in fidelity to his brother. He obliged the people of Khorasan to take an oath of fidelity to Al Amin, and reduced some who had actually excited a considerable body of the people to revolt, while the general Al Fadl having ingratiated himself with the caliph by his ready compliance with his orders, was chosen prime vizir, and governed with an absolute sway: Al Amin abandoning himself entirely to drunkenness.

20 Infamous behaviour of the new caliph.

Al Fadl was a very able minister; though fearing Al Mamun's resentment if ever he should ascend the throne, he gave Al Amin such advice as proved in the end the ruin of them both. He told him that his brother had gained the affection of the people of Khorasan by the good order and police he had established among them; that his unwearied application to the administration of justice had so attracted their esteem, that the whole province was entirely at his devotion; that his own conduct was by no means relished by his subjects, whose minds were almost totally alienated from him; and therefore that he had but one part to act, which was to deprive Al Mamun of the right of succession that had been given him by his father, and transfer it to his own son Musa, though then but an infant. Agreeable to this pernicious advice, the caliph sent for his brother Al Kasem from Mesopotamia, and recalled Al Mamun from Khorasan, pretending he had occasion for him as an assistant in his councils.

21 Al Mamun takes up arms against his brother.

By this treatment Al Mamun was so much provoked, that he resolved to come to an open rupture with his brother, in order if possible to frustrate his wicked designs. Instead, therefore, of going to Bagdad as he had been commanded, he cut off all communication between his own province and that capital: pretending, that as his father Harun had assigned him the lieutenancy of Khorasan, he was responsible for all the disorders that might happen there during his absence. He also coined money, and would not suffer Al Amin's name to be impressed upon any of the dirhems or dinars struck in that province. Not content with this, he prevailed upon Rafe Ebn Al Leith, who had been for some time in rebellion, to join him with a body of troops; whose example was soon after followed by Harthema Ebn Aafan; which put him in possession of all the vast territory of Khorasan. Here he governed with an absolute sway, officiated in the mosque as *Iman*, and from the pulpit constantly harangued the people.

The following year, being the 195th year of the Hegira, beginning October 4. 810, the caliph Al-Amin, finding that his brother set him at defiance, declared war against him, and sent his general Ali Ebn Isa with an army of 60,000 men to invade Khorasan. Al Mamun, being informed that Ali was advancing against him with such a powerful army, put on foot all the troops he could raise, and gave the command to Thaher Ebn Hosein, one of the greatest generals of his age. Thaher being a man of undaunted resolution, chose only 4000 men whom he led against Al Amin's army. Ali, seeing so small a number of troops advancing against him, was transported with joy, and promised himself an easy victory. Despising his enemies, therefore, he behaved in a secure and careless manner; the consequence of which was, that his army was entirely defeated, and himself killed, his head being afterwards sent as a present to Al Mamun, who amply rewarded Thaher and Harthema for their services.

22 Al Amin's forces defeated.

After this victory, Al Mamun assumed the title of *caliph*, ordered Al Amin's name to be omitted in the public prayers, and made all necessary preparations for carrying the war into the very heart of his brother's dominions. For this purpose he divided his forces into two bodies, and commanded them to march into Irak by different routes. One of them obeyed the orders of Thaher, and the other of Harthema. The first directed his march towards Ahwas, and the other towards Holwan, both of them proposing to meet in the neighbourhood of Bagdad, and after their junction to besiege that city.

In the 196th year of the Hegira, Thaher Ebn Hosein made a most rapid progress with the troops under his command. Having advanced towards Ahwas, he there defeated a body of the caliph's forces; and though the victory was by no means decisive, it so intimidated the commander of Ahwas, that he thought fit to surrender that fortress to him. This opened him a way to Waset upon the Tigris, and facilitated the conquest of that place. After this he marched with his army to Al Madayen; the inhabitants of which immediately opened their gates to him. The rapidity of these conquests, and the infamous conduct of Al Amin, excited the people of Egypt, Syria, Hejaz, and Yaman, unanimously to declare for Al Mamun; who was accordingly proclaimed caliph in all these provinces. 23 Al Mamun's rapid conquests.

The next year, Al Mamun's forces under Thaher and Harthema, laid siege to Bagdad. As the caliph was shut up in that place, and it had a numerous garrison, the besieged made a vigorous defence, and destroyed a great number of their enemies. The besiegers, however, incessantly played upon the town with their catapults and other engines, though they were in their turn not a little annoyed by the garrison with the same sort of military machines. The latter likewise made 24 Siege of Bagdad.

Bagdad. continual sallies, and fought like men in despair, though they were always at last beaten back into the town with considerable loss. In short the siege continued during the whole of this year, in which the greatest part of the eastern city, called the *Camp of Al Mohdi*, was demolished or reduced to ashes. The citizens, as well as the garrison, were reduced to the last extremity, by the length and violence of the siege.

In the beginning of the 198th year of the Hegira, Al Amin finding himself deserted by his troops, as well as by the principal men of Bagdad, who had kept a private correspondence with Thaher, was obliged to retire to the old town on the west bank of the Tigris. He did not, however, take this step, before the inhabitants of the new town had formally deposed him, and proclaimed his brother Al Mamun caliph. Thaher, receiving advice of this, caused the old town to be immediately invested, planted his engines against it, and at last starved it to surrender. Al Amin being thus reduced to the necessity of putting himself into the hands of one of the generals, chose to implore the protection of Harthema, whom he judged to be of a more humane disposition than Thaher. Having obtained this, he embarked in a small vessel in order to arrive at that part of the camp where Harthema was posted; but Thaher being informed of his design, which, if put in execution, he thought would eclipse the glory he had acquired, laid an ambush for him, which he had not the good fortune to escape. Upon his arrival in the neighbourhood of Harthema's tent, Thaher's soldiers rushed upon him, drowned all his attendants, and put himself in prison. Here he was soon after massacred by Thaher's servants, who carried his head in triumph to their master, by whose order it was afterwards exposed to public view in the streets of Bagdad. Thaher afterwards sent to Al Mamun in Khorasan, together with the ring or seal of the caliphate, the sceptre, and the imperial robe. At the sight of these, Al Mamun fell down on his knees, and returned thanks to God for his success; making the courier who brought them a present of a million of dirhems, in value about 100,000l. Sterling.

25 Al Amin murdered.

26 Succeeded by Al Mamun.

The same day that Al Amin was assassinated, his brother Al Mamun was proclaimed caliph at Bagdad. He had not long been seated on the throne when he was alarmed by rebellions breaking out in different parts of the empire. These, however, were at last happily extinguished; after which, Thaher Ebn Hosein had the government of Khorasan conferred upon him and his descendants with almost absolute and unlimited power. This happened in the 205th year of the Hegira, from which time we may date the dismemberment of that province from the empire of the caliphs.

27 Khorasan dismembered from the empire.

During the reign of this caliph nothing remarkable happened; only the African Moslems invaded the island of Sicily, where they made themselves masters of several places. He died of a surfeit in the 218th year of the Hegira, having reigned 20, and lived 48 or 49 years.

28 Death of Al Mamun.

On the death of Al Mamun, his brother Al Motasem, by some of the oriental historians surnamed *Billah*, was saluted caliph. He succeeded by virtue of Al Mamun's express nomination of him to the exclusion of his own son Al Abbas and his other brother Al Kasem, who had been appointed by Harun Al Raschid. In the beginning of his reign he was obliged to employ the whole forces of his empire against one Babec, who had been for a considerable time in rebellion in Persia and Persian Irak. This Babec first appeared in the year of the Hegira 201, when he began to take upon him the title of a *prophet*. What his particular doctrine was, is now unknown; but his religion is said to have differed from all others then known in Asia. He gained a great number of proselytes in Aderbijan and the Persian Irak, where he soon grew powerful enough to wage war with the caliph Al Mamun, whose troops he often beat, so that he was now become extremely formidable. The general sent by Al Motasem to reduce him was Haider Ebn Kaus, surnamed *Afshin*, a Turk by nation, who had been brought a slave to the caliph's court, and having been employed in disciplining the Turkish militia there, had acquired the reputation of a great captain. By him Babec was defeated with prodigious slaughter, no fewer than 60,000 men being killed in the first engagement. The next year, being the 220th of the Hegira, he received a still greater overthrow, losing 100,000 men either killed or taken prisoners. By this defeat he was obliged to retire into the Gordyæan mountains; where he fortified himself in such a manner, that Afshin found it impossible to reduce him till the year of the Hegira 222. This commander having reduced with invincible patience all Babec's castles one after another, the impostor was obliged to shut himself up in a strong fortress called *Cashabad*, which was now his last resource. Here he defended himself with great bravery for several months; but at last finding he should be obliged to surrender, he made his escape into a neighbouring wood, from whence he soon after came to Afshin, upon that general's promising him pardon. But Afshin no sooner had him in his power, than he first caused his hands and feet, and afterwards his head, to be cut off. Babec had supported himself against the power of the caliphs for upwards of 20 years, during which time he had cruelly massacred 250,000 people; it being his custom to spare neither man, woman, nor child, of the Mahometans or their allies. Amongst the prisoners taken at Cashabad there was one Nud, who had been one of Babec's executioners, and who owned that in obedience to his master's commands he had destroyed 20,000 Moslems with his own hands; to which he added, that vast numbers had also been executed by his companions, but that of these he could give no precise account.

29 War between the new caliph Al Motasem and Babec.

30 Babec defeated.

31 Taken prisoner and put to death.

32 He destroyed vast numbers of Moslems.

In the 223d year of the Hegira, the Greek emperor Theophilus invaded the caliph's territories, where he behaved with the greatest cruelty, and by destroying Sozopetra the place of Al Motasem's nativity, notwithstanding his earnest entreaties to the contrary, occasioned the terrible destruction of *Amorium* mentioned under that article. The rest of this caliph's reign is remarkable for nothing but the execution of Afshin, who was accused of holding correspondence with the caliph's enemies. After his death a great number of idols were found in his house, which were immediately burned, as also several books said to contain impious and detestable opinions.

In the 227th year of the Hegira died the caliph Al Motasem, in the 48th or 49th year of his age. He reigned eight years eight months and eight days, was born

33 Death of Al Motasem.

Bagdad. born in the eighth month of the year, fought eight battles, had 8000 ſlaves, and had 8,000,000 dinars and 80,000 dirhems in his treaſury at his death, whence the oriental hiſtorians give him the name of *Al Mothamen*, or the *Octonary*. He is ſaid to have been ſo robuſt, that he once carried a burden of 1600 pounds weight ſeveral paces. As the people of Bagdad diſturbed him with frequent revolts and commotions, he took the reſolution to abandon that city, and build another for his own reſidence. The new city he built was firſt called *Samarra*, and afterwards *Sarra Manray*, and ſtood in the Arabian Irak. He was attached to the opinion of the Motazalites, who maintain the creation of the Koran; and both he and his predeceſſor cruelly perſecuted thoſe who believed it to be eternal.

34 He built the city of Sarra Manray.

35 His ſucceſſors Al Wathek and Al Motawakkel.

Al Motaſem was ſucceeded by Al Wathek Bilah, who the following year, being the 228th of the Hegira, invaded and conquered Sicily. Nothing remarkable happened during the reſt of his reign; he died in the 232d year of the Hegira, and was ſucceeded by his brother Al Motawakkel.

36 Monſtrous cruelty of Al Motawakkel.

The new caliph began his reign with an act of the greateſt cruelty. The late caliph's vizir having treated Al Motawakkel ill in his brother's lifetime, and oppoſed his election to the caliphate, was on that account now ſent to priſon. Here the caliph ordered him to be kept awake for ſeveral days and nights together: after this, being ſuffered to fall aſleep, he ſlept a whole day and a night; and after he awoke was thrown into an iron furnace lined with ſpikes or nails heated red hot, where he was miſerably burnt to death. During this reign nothing remarkable happened, except wars with the Greeks, which were carried on with various ſucceſs. In the year 859 too, being the 245th of the Hegira, violent earthquakes happened in many provinces of the Moſlem dominions; and the ſprings at Mecca failed to ſuch a degree, that the celebrated well Zemzem was almoſt dried up, and the water ſold for 100 dirhems a bottle.

37 He is aſſaſſinated.

In the 247th year of the Hegira, the caliph was aſſaſſinated at the inſtance of his ſon Al Montaſer; who ſucceeded him, and died in ſix months after. He was ſucceeded by Al Moſtain, who in the year of the Hegira 252 was forced to abdicate the throne by his brother Al Motazz, who afterwards cauſed him to be privately murdered. He did not long enjoy the dignity of which he had ſo iniquitouſly poſſeſſed himſelf; being depoſed by the Turkiſh militia (who now began to ſet up and depoſe caliphs as they pleaſed) in the 255th year of the Hegira. After his depoſition, he was ſent under an eſcort from Sarra Manray to Bagdad, where he died of thirſt or hunger, after a reign of four years and about ſeven months. The fate of this caliph was peculiarly hard: the Turkiſh troops had mutinied for their pay; and Al Motazz, not having money to ſatisfy their demands, applied to his mother named *Kabiha* for 50,000 dinars. This ſhe refuſed, telling him that ſhe had no money at all, although it afterwards appeared that ſhe was poſſeſſed of immenſe treaſures. After his depoſition, however, ſhe was obliged to diſcover them, and even depoſite them in the hands of the new caliph Al Mokhtadi. They conſiſted of 1,000,000 dinars, a buſhel of emeralds, and another of pearls, and three pounds and three quarters of rubies of the colour of fire.

38 Hard fate of Al Motazz, a ſucceeding caliph.

Al Mokhtadi, the new caliph, was the ſon of one of Al Wathek's concubines named *Korb*, or *Karb*, who is by ſome ſuppoſed to have been a Chriſtian. The beginning of his reign is remarkable for the irruption of the Zengians, a people of Nubia, Ethiopia, and the country of the Caffres, into Arabia, where they penetrated into the neighbourhood of Baſra and Cufa. The chief of this gang of robbers, who, according to ſome of the Arab hiſtorians, differed but little from wild beaſts, was Ali Ebn Mohammed Ebn Abdalrahman, who falſely gave himſelf out to be of the family of Ali Ebn Abu Taleb. This made ſuch an impreſſion upon the Shiites in thoſe parts, that they flocked to him in great numbers; which enabled him to ſeize upon the cities of Baſrah and Ramla, and even to paſs the Tigris at the head of a formidable army. He then took the title of *Prince of the Zenjians*, in order to ingratiate himſelf with thoſe barbarians, of whom his army was principally compoſed.

39 Irruption of the Zenjians in the reign of Al Mokhtadi.

In the 256th year of the Hegira, Al Mokhtadi was barbarouſly murdered by the Turks who had raiſed him to the throne, and was ſucceeded by Al Montamed the ſon of Al Motawakkel. This year the prince of the Zenjians, Ali, or as he is alſo called *Al Habib*, made incurſions to the very gates of Bagdad, doing prodigious miſchief wherever he paſſed. The caliph therefore ſent againſt him one Jolan with a conſiderable army; he was overthrown, however, with very great ſlaughter by the Zenjian, who made himſelf maſter of 24 of the caliph's largeſt ſhips in the bay of Baſra, put a vaſt number of the inhabitants of Obolla to the ſword, and ſeized upon the town. Not content with this, he ſet fire to it, and ſoon reduced it to aſhes, the houſes moſtly conſiſting of the wood of a certain plane tree called by the Arabians *Saj*. From thence he marched to Abadan, which likewiſe ſurrendered to him. Here he found immenſe treaſure, which enabled him to poſſeſs himſelf of the whole diſtrict of Ahwaz. In ſhort, his forces being now increaſed to 80,000 ſtrong, moſt of the adjacent territories, and even the caliph's court itſelf, were ſtruck with terror.

40 Al Habib's ſucceſs.

In the 257th year of the Hegira, Al Habib continued victorious, defeated ſeveral armies ſent againſt him by the caliph, reduced the city of Baſrah, and put 20,000 of the inhabitants to the ſword. The following year, the caliph, ſupported by his brother Al Mowaffek, had formed a deſign of circumſcribing the power of the Turkiſh ſoldiery, who had for ſome time given law to the caliphs themſelves. But this year the Zenjians made ſo rapid a progreſs in Perſia, Arabia, and Irak, that he was obliged to ſuſpend the execution of his deſign, and even to employ the Turkiſh troops to aſſiſt his brother Al Mowaffek in oppoſing theſe robbers. The firſt of the caliph's generals who encountered Al Habib this year, was defeated in ſeveral engagements, and had his army at laſt entirely deſtroyed. After this Al Mowaffek and another general named *Moſleh*, advanced againſt him. In the firſt engagement Moſleh being killed by an arrow, the caliph's troops retired; but Al Mowaffek put them afterwards in ſuch a poſture of defence, that the enemy durſt not renew the attack. Several other ſharp encounters happened this year, in which neither party gained great advantage; but, at laſt, ſome contagious diſtempers breaking out

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out in Al Mowaffek's army, he was obliged to conclude a truce, and retire to Wafet to refresh his troops.

In the 259th year of the Hegira, commencing Nov. 7. 872, the war between the caliph and Al Habib still continued. Al Mowaffek, upon his arrival at Bagdad, sent Mohammed surnamed *Al Mowalled* with a powerful army to act against the Zenjians; but he could not hinder them from ravaging the province of Ahwaz, cutting off about 50,000 of the caliph's subjects, and dismantling the city of Ahwaz; and notwithstanding the utmost efforts of all the caliph's generals, no considerable advantages could be gained either this or the following year.

41 Rebellion in Fars, Ahwaz, and Basra.

In the 261st year of the Hegira, beginning October 16. 874, Mohammed Ebn Wasel, who had killed the caliph's governor of Fars, and afterwards made himself master of that province, had several engagements with Al Habib, but with what success is not known. The caliph, having been apprized of the state of affairs on that side, annexed the government of Fars, Ahwaz, and Basrah, to the prefecture he had given to Musa Ebn Baga, whom he looked upon as one of the best generals he had. Musa, soon after his nomination to that post, sent Abdalrahman Ebn Mosleh as his deputy to Ahwaz, giving him as a colleague and assistant one Tisam, a Turk. Mohammed Ebn Wasel, however, refusing to obey the orders of Abdalrahman and Tisam, a fierce conflict ensued, in which the latter was defeated, and Abdalrahman taken prisoner. After this victory, Mohammed advanced against Musa Ebn Boga himself; but that general finding he could not take possession of his new government without a vast effusion of blood, recalled the deputies from their provinces, and made the best of his way to Sarra Manray. After this, Yakub Ebn Al Leit, having taken Khorasan from the descendants of Thaher, attacked and defeated Mohammed Ebn Wasel, seizing on his palace, where he found a sum of money amounting to 40,000,000 dirhems.

42 Rebels defeated, but cannot be reduced.

The next year Yakub Ebn Leit being grow formidable by the acquisition of Ahwaz and a considerable portion of Fars, or at least the Persian Irak, declared war against the caliph. Against him Al Motamed despatched Al Mowaffek; who having defeated him with prodigious slaughter, plundered his camp, and pursued him into Khorasan; where meeting with no opposition, he entered Nisabur, and released Mahomet the Thaherian, whom Yakub had detained in prison three years. As for Yakub himself, he made his escape with great difficulty, though he and his family continued several years in possession of many of the conquests he had made. This war with Yakub proved a seasonable diversion in favour of Al Habib, who this year defeated all the forces sent against him, and ravaged the district of Wafet.

43 Al Habib still victorious.

The following year, being the 263d of the Hegira, beginning September 24. 876, the caliph's forces, under the command of Ahmed Ebn Lebuna, gained two considerable advantages over Al Habib; but being at last drawn into an ambuscade, they were almost totally destroyed, their general himself making his escape with the utmost difficulty; nor were the caliph's forces able, during the course of the next year, to make the least impression upon these rebels.

In the 265th year of the Hegira, beginning September 3. 878, Ahmed Ebn Tolun rebelled against the caliph, and set up for himself in Egypt. Having assembled a conderable force, he marched to Antioch, and besieged Sima the governor of Aleppo and all the provinces known among the Arabs by the name of *Al Awasem*, in that city. As the besieged found that he was resolved to carry the place by assault, they thought fit, after a short defence, to submit, and to put Sima into his hands. Ahmed no sooner had that officer in his power, than he caused him to be beheaded; after which he advanced to Aleppo, the gates of which were immediately opened unto him. Soon after, he reduced Damascus, Hems, Hamath, Kinnisrin, and Al Rakka, situated upon the eastern bank of the Euphrates. This rebellion so exasperated Al Motamed, that he caused Ahmed to be publicly cursed in all the mosques belonging to Bagdad and Irak; and Ahmed on his part ordered the same malediction to be thundered out against the caliph in all the mosques within his jurisdiction. This year also a detachment of Al Habib's troops penetrated into Irak, and made themselves masters of four of the caliph's ships laden with corn; then they advanced to Al Nomanic, laid the greatest part of it in ashes, and carried off with them several of the inhabitants prisoners. After this they possessed themselves of Jarjaraya, where they found many prisoners more, and destroyed all the adjacent territory with fire and sword. This year there were four independent powers in the Moslem dominions, besides the house of Ommiyah in Spain, viz. The African Moslems, or Aglabites, who had for a long time acted independently; Ahmed in Syria and Egypt; Al Leit in Khorasan; and Al Habib in Arabia and Irak.

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44 Rebellion in Egypt which cannot be suppressed.

45 Four independent powers in the caliph's nominal dominions.

In the 266th year of the Hegira, beginning August 23. 879, Al Habib reduced Ramhormoz, burnt the stately mosque there to the ground, put a vast number of the inhabitants to the sword, and carried away great numbers, as well as a vast quantity of spoil.— This was his last successful campaign; for the year following, Al Mowaffek, attended by his son Abul Abbas, having attacked him with a body of 10,000 horse and a few infantry, notwithstanding the vast disparity of numbers (Al Habib's army amounting to 100,000 men), defeated him in several battles, recovered most of the towns he had taken, together with an immense quantity of spoil, and released 5000 women that had been thrown into prison by these barbarians. After these victories, Al Mowaffek took post before the city of Al Mabiya', built by Al Habib, and the place of his residence; burnt all the ships in the harbour; thoroughly pillaged the town; and then entirely dismantled it. After the reduction of this place, in which he found immense treasures, Al Mowaffek pursued the flying Zenjians, put several of their chiefs to the sword, and advanced to Al Mokhtara, a city built by Al Habib. As the place was strongly fortified, and Al Habib was posted in its neighbourhood, with an army, according to Abu Jaafer Al Tabari, of 300,000 men, Al Mowaffek perceived that the reduction of it would be a matter of some difficulty. He therefore built a fortress opposite to it, where he erected a mosque, and coined money. The new city, from its founder, was called by the Arabs *Al Mowaffekkia*, and soon rendered considerable by the settlement of several wealthy merchants there. The city of Al Mokhtara being reduced to great straits was at last taken by storm, and given up to

46 Al Habib's bad success and death.

Bagdad. be plundered by the caliph's troops; after which Al Mowaffek defeated the numerous forces of Al Habib in fuch a manner, that they could no more be rallied during that campaign.

The following year, being the 268th of the Hegira, Al Mowaffek penetrated again into Al Mabiya', and demolifhed the fortifications which had been raifed fince its former reduction, though the rebels difputed every inch of ground. Next year he again attacked Al Habib with great bravery; and would have entirely defeated him, had he not been wounded in the breaft with an arrow, which obliged him to found a retreat. However, as foon as he was cured of his wound, Al Mowaffek advanced a third time to Al Mabiya', made himfelf mafter of that metropolis, threw down the walls that had been raifed, put many of the inhabitants to the fword, and carried a vaft number of them into captivity.

The 27th year of the Hegira, commencing July 11th 883, proved fatal to the rebel Al Habib. Al Mowaffek made himfelf a fourth time mafter of Al Mabiya', burnt Al Habib's palace, feized upon his family, and fent them to Sarra Manray. As for the ufurper himfelf, he had the good fortune to efcape at this time; but being clofely purfued by Al Mowaffek into the province of Ahwaz, where the fhattered remains of his forces were entirely defeated, he at laft fell into the hands of the victor, who ordered his head to be cut off, and carried through a great part of that region which he had fo long difturbed. By this complete victory Al Mowaffek obtained the title of *Al Nafir Lidmilbah*, that is, *the protector of Mahometanifm*. This year alfo died Ahmed Ebn Tolun, who had feized upon Egypt and Syria, as we have already obferved: and was fucceeded by his fon *Khamarawiyah*.

47 Succefs of the fultan of Egypt.

The next year, a bloody engagement happened between the caliph's forces commanded by Al Mowaffek's fon, and thofe of Khamarawiyah, who had made an irruption into the caliph's territories. The battle was fought between Al Ramla and Damafcus. In the beginning, Khamarawiyah found himfelf fo hard preffed, that his men were obliged to give way; upon which, taking for granted that all was loft, he fled with great precipitation, even to the borders of Egypt; but, in the mean time, his troops being ignorant of the flight of their general, returned to the charge, and gained a complete victory. After this, Khamarawiyah, by his juft and mild adminiftration, fo gained the affections of his fubjects, that the caliph found it impoffible to gain the leaft advantage over him. In the 276th year of the Hegira, he overthrew one of the caliph's generals named Abul Saj, at Al Bathnia near the city of Damafcus; after which he advanced to Al Rakka on the Euphrates, and made himfelf mafter of that place. Having annexed feveral large provinces to his former dominions, and left fome of his friends in whom he could confide to govern them, he then returned into Egypt, the principal part of his empire, which now extended from the Euphrates to the borders of Nubia and Ethiopia.

48 Al Mowaffek dies.

The following year, being the 278th of the Hegira, was remarkable for the death of Al Mowaffek. He died of the elephantiafis or leprofy; and while in his laft illnefs, could not help obferving, that of 100,000 men whom he commanded, there was not one fo miferable as himfelf. This year is alfo remarkable for the firft difturbances raifed in the Moflem empire by the Karmatians. The origin of this fect is not certainly known;

49 Origin of the Karmatians.

but the moft common opinion is, that a poor fellow, by fome called *Karmata*, came from Khuzeftan to the villages near Cufa, and there pretended great fanctity and ftrictnefs of life, and that God had enjoined him to pray 50 times a-day; pretending alfo to invite people to the obedience of a certain Imam of the family of Mahomet; and this way of life he continued till he had made a very great party, out of whom he chofe twelve as his apoftles to govern the reft, and to propagate his doctrines. He alfo affumed the title of *prince*, and obliged every one of his earlier followers to pay him a dinar a-year. But Al Haidam, the governor of that province, finding men neglected their work, and their hufbandry in particular, to fay thofe 50 prayers a-day, feized the fellow, and having put him in prifon, fwore that he fhould die. This being overheard by a girl belonging to the governor, fhe, out of compaffion, took the key of the dungeon at night from under her mafter's head, releafed the man, and reftored the key to its place while her mafter flept. The next morning the governor found his prifoner gone; and the accident being publicly known, raifed great admiration; Karmata's adherents giving out that God had taken him into heaven. After this he appeared in another province, and declared to a great number of people he got about him, that it was not in the power of any perfon to do him hurt; notwithftanding which, his courage failing him, he retired into Syria, and was never heard of any more. After his difappearance, the fect continued and increafed; his difciples pretending that their mafter had manifefted himfelf to be a true prophet, and had left them a new law, wherein he had changed the ceremonies and form of prayer ufed by the Moflems, &c. From this year, 278, thefe fectaries gave almoft continual difturbance to the caliphs and their fubjects, committing great diforders in Chaldæa, Arabia, and Mefopotamia, and at length eftablifhed a confiderable principality.

50 Sultan of Egypt's daughter married to the caliph Al Motaded.

In the 279th year of the Hegira died the caliph Al Motamed; and was fucceeded by Al Motaded, fon to Al Mowaffek. The firft year of his reign, Al Motaded demanded in marriage the daughter of Khamarawiyah, fultan, or caliph, of Egypt; which was agreed to by him with the utmoft joy, and their nuptials were folemnized with great pomp in the 282d year of the Hegira. He carried on a war with the Karmatians; but very unfuccefsfully, his forces being defeated with great flaughter, and his general Al Abbas taken prifoner. This caliph alfo granted to Harun, fon to Khamarawiyah, the perpetual perfecture of Awafam and Kinnifrin, which he annexed to that of Egypt and Syria, upon condition that he paid him an annual tribute of 45,000 dinars. He died in the year of the Hegira 289, and was fucceeded by his fon Al Moctafi.

51 Egypt, &c. recovered by the caliph Al Moctafi.

This caliph proved a warlike and fuccefsful prince. He gained feveral advantages over the Karmatians, but was not able to reduce them. The Turks, however, having invaded the province of Mawaralnahr, were defeated with great flaughter; after which, Al Moctafi carried on a fuccefsful war againft the Greeks, from whom he took Seleucia. After this he invaded Syria and

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and Egypt, which provinces he recovered from the houſe of Ahmed Ebn Tolun.

52 Diſtreſſed ſtate of the caliphs after his death.

The reduction of Egypt happened in the 292d year of the Hegira, after which the war was renewed with ſucceſs againſt the Greeks and Karmatians. The caliph died in the 295th year of the Hegira, after a reign of about ſix years and a half. He was the laſt of the caliphs who made any figure by their warlike exploits, His ſucceſſors Al Moktader, Al Kaher, and Al Radi, were ſo diſtreſſed by the Karmatians and numberleſs uſurpers who were every day ſtarting up, that by the 325th year of the Hegira they had nothing left but the city of Bagdad. In the 324th year of the Hegira, commencing November 30. 935, the caliph Al Radi, finding himſelf diſtreſſed on all ſides by uſurpers, and having a vizir of no capacity, inſtituted a new office ſuperior to that of vizir, which he entitled *Emir Al Omra*, or *Commandant of commandants*. This great officer was truſted with the management of all military affairs, and had the entire management of the finances in a much more abſolute and unlimited manner than any of the caliph's vizirs ever had. Nay, he officiated for the caliph in the great moſque at Bagdad, and had his name mentioned in the public prayers throughout the kingdom. In ſhort, the caliph was ſo much under the power of this officer, that he could not apply a ſingle dinar to his own uſe without the leave of the Emir Al Omra. In the year 325, the Moſlem empire, once ſo great and powerful, was ſhared among the following uſurpers.

53 New office of Emir Al Omra inſtituted by Al Radi.

54 Diviſion of the Moſlem empire in the 325th year of the Hegira.

The cities of Waſet, Baſra, and Cufa, with the reſt of the Arabian Irak, were conſidered as the property of the Emir Al Omra, though they had been in the beginning of the year ſeized upon by a rebel called *Al Baridi*, who could not be driven out of them.

The country of Fars, Farſeſtan, or *Perſia* properly ſo called, was poſſeſſed by Amado'ddawla Ali Ebn Buiya, who reſided in the city of Shiraz.

Part of the tract denominated *Al Jebal*, together with Perſian Irak, which is the mountainous part of Perſia, and the country of the ancient Parthians, obeyed Rucno'ddowla, the brother of Amado'ddawla, who reſided at Iſpahan. The other part of that country was poſſeſſed by Waſhmakin the Deylamite.

Diyar Rabia, Diyar Becr, Diyar Modar, and the city of Al Mawſel, or Moſul, acknowledged for their ſovereigns a race of princes called *Hamdanites*.

Egypt and Syria no longer obeyed the caliphs, but Mahomet Ebn Taj, who had formerly been appointed governor of theſe provinces.

Africa and Spain had long been independent.

Sicily and Crete were governed by princes of their own.

The provinces of Khoraſan and Mawaralnahr were under the dominion of Al Naſr Ebn Ahmed, of the dynaſty of the Sammarians.

The provinces of Tabreſtan, Jorjan, or Georgia, and Mazanderan, had kings of the firſt dynaſty of the Deylamites.

The province of Kerman was occupied by Abu Ali Mahomet Ebn Eylia Al Sammani, who had made himſelf maſter of it a ſhort time before. And,

Laſtly, the provinces of Yamama and Bahrein, including the diſtrict of Hajr, were in the poſſeſſion of Abu Thaher the Karmatian.

Thus the caliphs were deprived of all their dominions, and reduced to the rank of ſovereign pontiffs; in which light, though they continued for ſome time to be regarded by the neighbouring princes, yet their power never arrived to any height. In this low ſtate the caliphs continued till the year of the Hegira 656, commencing January 8. 1258. This year was rendered remarkable by the taking of Bagdad by Hulaku the Mogul or Tartar; who likewiſe aboliſhed the caliphate, putting the reigning caliph Al Moſtaſem Bilah to a moſt cruel death. Theſe diabolical conquerors, after they had taken the city, maſſacred, according to cuſtom, a vaſt number of the inhabitants; and after they had plundered it, ſet it on fire. The ſpoil they took from thence was prodigiouſly great, Bagdad being then looked upon as the firſt city in the world.

55 Bagdad taken by the Tartars.

Bagdad remained in the hands of the Tartars or Moguls to the year of the Hegira 795, of Chriſt 1392, when it was taken by Tamerlane from Sultan Ahmed Ebn Weis; who being incapable of making head againſt Tamerlane's numerous forces, found himſelf obliged to ſend all his baggage over the Tigris, and abandoned his capital to the conqueror. He was, however, hotly purſued by his enemy's detachments to the plain of Karbella, where ſeveral ſkirmiſhes happened, and a conſiderable number of men were loſt on both ſides. Notwithſtanding this diſaſter, he found means to eſcape the fury of his purſuers, took refuge in the territories of the Greek emperor, and afterwards repoſſeſſed himſelf of the city of Bagdad. There he remained till the year of the Hegira 803, when the city was taken a ſecond time by Tamerlane; who nevertheleſs reſtored it to him, and he continued ſovereign of the place till driven from thence by Miram Shaw. Still, however, he found means to return; but in the 815th year of the Hegira was finally expelled by Kara Yuſef the Turcoman. The deſcendants of Kara Yuſef continued maſters of Bagdad till the year of the Hegira 875, of Chriſt 1470, when they were driven out by Uſun Caſſun. The family of this prince continued till the year of the Hegira 914, of our Lord 1508, when Shah Iſhmael, ſurnamed *Sufi* or *Sofi*, the firſt prince of the royal family reigning in Iran or Perſia, till the dethroning of the late Shah Hoſein, made himſelf maſter of it. From that time to this Bagdad has continued to be a bone of contention between the Turks and Perſians. It was taken by Soliman ſurnamed the *magnificent*, and retaken by Shah Abbas the great, king of Perſia; but being at length beſieged by Amruth or Morad IV. with a formidable army, it was finally obliged to ſurrender to him in the year 1638; ſince which time the Perſians have never been able to make themſelves maſters of it for any length of time.

56 Hiſtory of the city ſince that time.

The city is large and populous; and the advantage of the Tigris is ſo conſiderable, with regard to commerce, that although the climate is exceſſively hot, and in other reſpects far from being agreeable, yet the number of its inhabitants is computed at 300,000; but before the plague broke out there, they were ſuppoſed to be four times that number. It is governed by a baſhaw, whoſe authority extends as far as Curdiſtan. The revenues would be immenſe was the government mild; but inſtead thereof, oppreſſion rules here with the moſt deſpotic ſway. The baſhaw is continually extorting money from the poor inhabitants, and none

57 Its preſent ſtate.

ſuffer

Bagdad. suffer more than the unfortunate Jews and Christians, many of whom are put to the most cruel tortures in order to force their property from them. This series of tyranny and oppression has almost entirely driven them out of the city; in consequence of which the trade must suffer very considerably, they being generally the principal merchants in the place. In the months of June, July, and August, the weather is so extremely hot, as to oblige the inhabitants to live for these months in subterraneous apartments, which are arched over, to admit the freer circulation of the air. The houses are generally large, built of brick and cement, and are arched over. Many of the windows are made of elegant Venetian glass; the ceilings are mostly ornamented with a kind of chequered work, which has generally a noble appearance; most of the houses have a court-yard before them, in the middle of which is a little plantation of orange trees, &c. that has a very pleasing effect. The soil, which would produce not only every conveniency in life, but almost every luxury, is through the natural indolence of the Turks, and the many faults in the government of the country, in a great measure uncultivated and neglected. The revenues are computed at 125 lacks of piastres, or 1,562,500l. sterling; but a quarter part of this is not collected, owing to the slothfulness of the Turks, who suffer the Arabs to plunder them of the remainder. This in some measure accounts for the cruelties and extortions that are continually practised here. As the bashaw lives in all the splendour of a sovereign prince, and maintains a very large army, he could not be able to defray his expences, was he not to have recourse to oppression and injustice; and he, by his extensive power, acting almost independent of the Porte, only acknowledges it to bring in a balance from thence yearly in his favour.

The bazars or markets here are large and extensive; being covered over with arches built of masonry, and divided into different streets, filled with shops of all kinds of merchandise, to the number of 12,000. Every thing a person can have occasion for may be had there. The number of houses in the city is computed at near 80,000; and each house and shop pay an annual tribute to the bashaw, which is calculated to produce the sum of 300,000l. sterling. Besides these immense revenues that are collected, the bashaw pretends, that by repairs on the fortifications 30,000l. or 40,000l. are annually expended, when not so many hundreds are taken out of his coffers for that purpose. Likewise clearing the river and mending the bridge become a charge greater than their income, and probably not the value of an English shilling is expended. —To support the expence of the seraglio, their clothes, caparisons of their horses, and every outward pomp, the amount is considerable.

On the north side of the town stands the citadel, which commands the river; and consists of curtains and bastions, on which some very long cannon are mounted, with two mortars in each bastion, placed on no other beds than the ground, and in very bad condition. The carriages of the guns are likewise so unwieldy, and in such a shattered condition, that from their appearance they would not support one firing, but would be shaken in pieces. Their elevations were from 30 to 40 degrees, but they had no quoins to level them. There are, besides, a number of small towers, and loop-holes for musketry, placed at certain distances, all well encompassed by a ditch of 25 feet deep, which can be filled at any time by the waters of the Tigris. The citadel is so close to the houses, that it might be easily taken if possession was once gained of the town; but an attack made towards the land would not probably be successful, as sluices might with the greatest facility be cut into the ditch, and so overflow the country for miles round; but it is said an advantageous attack might be made from the water. Bagdad.

The city, which is fortified by lofty thick walls of brick covered with earth, and strengthened by great towers much resembling cavalier bastions, the whole being surrounded by a deep ditch, is in the form of an irregular square; but the walls in many places are broken down, occasioned by the disputes which happened on the death of Abdulla Bashaw a few years ago, when two competitors arose in Bagdad for the bashawic, who fought several times in the town and citadel, and laid great part of it in ruins. In the interim, the governor of Moussul and Nineveh being appointed bashaw by the Porte, came hither with a considerable army, and took possession of the sovereignty, vanquishing his two opponents. Opposite to the city, on the other side of the river, are very extensive suburbs, from whence shells might be thrown into the town, which would have a dreadful effect on a place so closely built. There is a communication between the city and suburbs by a bridge of boats; the only kind of bridge which that river will admit of, as it is broad and deep, and in its ordinary course very rapid. At certain seasons it swells to a prodigious height, and overflowing the country occasions many morasses on that side opposite to the city. Among these are several towns and villages, whose inhabitants are said to be the ancient Chaldeans: they are of a particular religion, which they pretend is that of Seth. The inhabitants of this city are composed chiefly of Persians, Armenians, Turks, Arabs, and Jews, which last act in the capacity of schroffs, or bankers, to the merchants. The Jews, notwithstanding the severe treatment they meet with from the government, are induced to live here from a reverence to the prophet Ezekiel, whose mausoleum they pretend is a day's journey from the city. Besides the Jews who reside here, there are many that come every year out of devotion to visit the prophet's tomb. There are also two European gentleman, a Venetian and a Frenchman, with five Romish priests, who are Frenchmen and Italians. Two chapels are permitted for those of the Romish and Greek persuasions; at the former the five priests officiate. In the city are several large beautiful mosques, but into which Christians are never suffered to enter if known to be such, for fear it should defile them. The Mahometan women are very richly dressed, wearing bracelets on their arms and jewels in their ears: the Arabian women have the partition between their nostrils bored, wherein they wear rings.

There are also a number of antique buildings. At the distance of about ten miles stand the ruins of an ancient tower called the *Tower of Nimrod*. Whether this tower was at first of a square or round form is now difficult to determine: though the former is most probable,

bable, becauſe all the remaining bricks are placed ſquare, and not in the leaſt circular. The bricks are all twelve inches ſquare and four and a half thick. The cement is of mud or ſlime, mixed with broken reed, as we mix hair with mortar; which ſlime might either have been had from one of the great rivers, or taken out of one of the ſwamps in the plain, with which the country hereabout very much abounds. The height of the ruin is 126 feet; the diameter of the largeſt and middle part about 100 feet. It would appear to be ſolid to the centre; yet near the top there is a regular opening of an oval form. The circumference of that part of the tower which remains, and is above the rubbiſh, is about 300 feet; but probably could the foundation be come at, it would be found of far greater extent. The preſent Turks, Jews, and Arabians, are fond of believing this to be the identical ruin of the ancient tower of Babel, for which they aſſign a variety of reaſons; but all ſo void of the appearance of truth, that to ſet about confuting them would be loſing time in trifles. It appears to have been a beacon or watch-tower, to give notice of the approach of an enemy: or perhaps was uſed as an obſervatory to inſpect the various motions of the heavenly bodies; which ſcience was ſo much cultivated among the ancient inhabitants of this country, that even the Grecians, though deſirous of being eſteemed the inventors of all arts and ſciences, could never deny the Babylonians the honour of having laid the foundations of aſtronomy.

BAGGAGE, in *Military Affairs*, denotes the clothes, tents, utenſils of divers ſorts, proviſions, and other neceſſaries belonging to the army.

Before a march, the waggons with the baggage are marſhalled according to the rank which the ſeveral regiments bear in the army; being ſometimes ordered to follow the reſpective columns of the army, ſometimes to follow the artillery, and ſometimes to form a column by themſelves. The general's baggage marches firſt; and each waggon has a flag, ſhowing the regiment to which it belongs.

Packing up the BAGGAGE, *vaſa colligere*, was a term among the Romans, for preparing to go to war, or to be ready for an expedition.

The Romans diſtinguiſhed two ſorts of baggage; a *greater* and *leſs*. The leſſer was carried by the ſoldier on his back, and called *ſarcina;* conſiſting of the things moſt neceſſary to life, and which he could not do without. Hence *colligere ſarcinas*, packing up the baggage, is uſed for decamping, *caſtra movere*. The greater and heavier was carried on horſes and vehicles, and called *onera*. Hence *onera vehiculorum, ſarcinæ hominum*. The baggage-horſes were denominated *ſagmentarii equi*.

The Roman ſoldiers in their marches were heavy loaden; inſomuch, that they were called by way of jeſt *muli mariani*, and *ærumnæ*. They had four ſorts of luggage, which they never went without, viz. corn or *buccellatum*, utenſils, valli, and arms. Cicero obſerves, that they uſed to carry with them above half a month's proviſions; and we have inſtances in Livy, where they carried proviſions for a whole month. Their utenſils comprehended thoſe proper for gathering fuel, dreſſing their meat, and even for fortification or intrenchment; and what is more, a chain for binding captives. For arms, the foot carried a ſpear, ſhield, ſaw, baſket, rutrum, hatchet, lorum, falx, &c. Alſo ſtakes or pales, *valli*, for the ſudden fortifying a camp; ſometimes ſeven or even twelve of theſe pales were carried by each man, though generally, as Polybius tells us, only three or four. On Trajan's column we ſee ſoldiers repreſented with this fardle of corn, utenſils, pales, &c. gathered into a bundle and laid on their ſhoulders. Thus inured to labour, they grew ſtrong, and able to undergo any fatigue in battle; the greateſt heat of which never tired them, or put them out of breath. In aftertimes, when diſcipline grew ſlack, this luggage was thrown on carriages and porters ſhoulders.

The Macedonians were not leſs inured to hardſhip than the Romans: when Philip firſt formed an army, he forbade all uſe of carriages; yet, with all their load, they would march, in a ſummer's day, 20 miles in military rank.

BAGLANA, or BUGLANA, a province of the kingdom of Dekkan in the Mogul's empire. It is bounded on the north and eaſt by Guzzerat and Ballagat; and on the ſouth and weſt by that part of Viſiapour called *Konhan*, belonging to the Mahrattas. It ends in a point at the ſea coaſt between Daman and Balſora, and is the leaſt province in the kingdom. The Portugueſe territories begin in this province at the port Daman, 21 leagues ſouth of Surat; and run along the coaſt by Baſſaim, Bombay, and Chawl, to Dabul, almoſt 50 leagues to the north of Goa.

BAGLIVI, GEORGE, a moſt illuſtrious phyſician of Italy, was a native of Apulia, and born about the year 1668. He ſtudied at Padua, where he became doctor; and then went to Rome, where he was choſen profeſſor of anatomy. He was a man of moſt uncommon force of underſtanding, of which he gave ample proofs in many curious and accurate productions, philoſophical as well as medicinal. He died at Rome 1706, in the flower of his age, and when he was no more than 38. A collection of his works was printed firſt in 1710, quarto; and has ſince been reprinted, in the ſame ſize, at various places. His *Praxis Medica*, and *De Fibra Matricis*, are the principal pieces. He wrote a Diſſertation upon the Anatomy, Bite, and Effects, of the Tarantula, which is the production of his country; and gave a particular account of the earthquake at Rome and the adjacent cities in 1703. His works are all in Latin.

BAGNAGAR, a town of Aſia, in the dominions of the Great Mogul, and capital of the kingdom of Golconda in the peninſula on this ſide the Ganges. The inhabitants within the town are the better ſort; the merchants and meaner people inhabiting the ſuburbs, which is three miles long. It is chiefly remarkable for a magnificent reſervoir of water, ſurrounded with a colonnade ſupported by arches. It is ſeated on the river Newa, in E. Long. 96. 0. N. Lat. 15. 30.

BAGNARA, a ſea-port town of Italy in the kingdom of Naples, in the farther Calabria, with the title of a duchy. E. Long. 16. 8. N. Lat. 38. 15.

BAGNAREA, a town of Italy in St Peter's patrimony, and in the territory of Orvieta, with a biſhop's ſee. E. Long. 12. 10. N. Lat. 42. 36.

BAGNERES, a town of France in Gaſcony, and in-

in the county of Bigorre, now the department of the Upper Pyrenees, so called from its mineral waters, which are much resorted to. It is seated on the river Adour, in E. Long. 0. 12. N. Lat. 43. 3.

BAGNIALACK, a large town of Turkey in Europe, in the province of Bosnia. E. Long. 18. 10. N. Lat. 44. 0.

BAGNIO, an Italian word, signifying *a bath*. We use it for a house with conveniences for bathing, cupping, sweating, and otherwise cleansing the body; and sometimes for worse purposes. In Turkey it is become a general name for the prisons where the slaves are enclosed, it being usual in these prisons to have baths.

BACNOLAS, a town of Lower Languedoc, now the department of Herault in France. It has a very handsome square, and two fountains which rise in the middle of the town; the waters of which, being received in a bason, are conveyed by a canal out of town, and from thence to the lands about it. E. Long. 4. 43. N. Lat. 44. 10.

BAGNOLIANS, or BAGNOLANSES, in *Church History*, a sect of heretics, who in reality were Manichees, though they somewhat disguised their errors. They rejected the Old Testament and part of the New; held the world to be eternal; and affirmed that God did not create the soul when he infused it into the body.

BAGOI, among the ancient Persians, were the same with those called by the Latins *spadones*, viz. a species of eunuchs, in whom the canal of the penis was so contorted by a tight vinculum, that they could not emit the semen.

BAG-PIPE, a musical instrument, of the wind kind, chiefly used in Scotland and Ireland. The peculiarity of the bag-pipe, and from which it takes its name, is, that the air which blows it is collected into a leathern bag, from whence it is pressed out by the arm into the pipes. These pipes consist of a bass, and tenor or rather treble; and are different according to the species of the pipe. The bass part is called the *drone*, and the tenor or treble part the *chanter*. In all the species, the bass never varies from its uniform note, and therefore very deservedly gets the name of *drone;* and the compass of the chanter is likewise very limited. There is a considerable difference between the Highland and Lowland bag-pipe of Scotland; the former being blown with the mouth, and the latter with a small bellows: though this difference is not essential, every species of bag-pipes being capable, by a proper construction of the reeds, of producing music either with the mouth or bellows. The following are the species of bag-pipes most commonly known in this country.

1. The *Irish Pipe*. This is the softest, and in some respects the most melodious of any, so that music-books have been published with directions how to play on it. The chanter, like that of all the rest, has eight holes like the English flute, and is played on by opening and shutting the holes as occasion requires; the bass consists of two short drones and a long one. The lowest note of the chanter is D on the German flute, being the open note on the counter-string of a violin; the small drone (one of them commonly being stopped up) is tuned in unison with the note above

this, and the large one to an octave below; so that a great length is required in order to produce such a low note, on which account the drone hath sometimes two or three turns. The instrument is tuned by lengthening or shortening the drone till it sounds the note desired.

2. The *Highland Bag-Pipe*. This consists of a chanter and two short drones, which sound in unison the lowest note of the chanter except one. This is exceedingly loud, and almost deafening if played in a room; and is therefore mostly used in the field, for marches, &c. It requires a prodigious blast to sound it; so that those unaccustomed to it cannot imagine how Highland pipers can continue to play for hours together, as they are often known to do. For the same reason, those who use the instrument are obliged either to stand on their feet or walk when they play. This instrument hath but nine notes; its scale, however, hath not yet been reduced to a regular standard by comparing it with that of other instruments, so that we can say nothing about its compass. Those who are best acquainted with it, however, affirm that it plays only the natural notes, without being capable of variation by flats or sharps.

3. The *Scots Lowland Pipe*. This is likewise a very loud instrument, though less so than the former. It is blown with bellows, and hath a bass like the Irish pipe. This species is different from all the rest, as it cannot play the natural notes, but hath F and C sharp. The lowest note of a good bag-pipe of this kind is unison with C sharp on the tenor of a violin tuned concert-pitch; and, as it hath but nine notes, the highest is D in alt. From this peculiar construction, the Highland and Lowland bag-pipes play two species of music essentially different from one another, as each of them also is from every other species of music in the world, Hence these two species of bag-pipes deserve notice as curiosities; for the music which they play is accompanied with such peculiar ornaments, or what are intended as such, as neither violin, or even organ, can imitate, but in a very imperfect manner.

This kind of bag-pipe was formerly very much used in Scotland at weddings and other festivals; being indeed extremely well calculated for playing that peculiar species of Scots music called *reels*. It has been often a matter of surprise how this was possible, as the instrument has only a compass of nine or ten notes at the utmost, and which cannot be varied as in other instruments. In this respect, however, it has a very great compass, and will play an inconceivable variety of tunes. As its notes are naturally so high, there is scarce any one tune but what is naturally transposed by it, so that what would be a flat note on the key proper for the violin, may be a sharp one on the bag-pipe; and though the latter cannot play any flat note, it may nevertheless in this manner play tunes which on other instruments would be flat, to as great perfection as these instruments themselves.

4. The *Small Pipe*. This is remarkable for its smallness, the chanter not exceeding eight inches in length; for which reason, the holes are so near each other, that it is with difficulty they can be closed. This hath only eight notes, the lower end of the chanter being commonly stopped. The reason of this is, to prevent the slurring of all the notes, which is unavoidable in the

other ſpecies; ſo that in the hands of a bad player they become the moſt ſhocking and unintelligible inſtruments imaginable: but this, by having the lower hole cloſed, and alſo by the peculiar way in which the notes are expreſſed, plays all its tunes in the way called by the Italians *ſtaccato*, and cannot ſlur at all. It hath no ſpecies of muſic peculiar to itſelf; and can play nothing which cannot be much better done upon other inſtruments; though it is ſurpriſing what volubility ſome performers on this inſtrument will diſplay, and how much they will overcome the natural diſadvantages of it. Some of this ſpecies, inſtead of having drones like the others, have their baſs parts conſiſting of a winding cavity in a kind of ſhort caſe, and are tuned by opening theſe to a certain degree by means of ſliding covers; from which contrivance they are called *ſhuttle-pipes*. Beſides theſe there are a variety of others, called *Italian*, *German*, *Organ*, &c. bag-pipes, which have nothing different in their conſtruction from thoſe above deſcribed, nor any good quality to recommend them.

As to the origin of bag-pipe muſic, ſome are of opinion that it is to be derived from the Danes; but Mr Pennant thinks differently, and gives the following reaſons for deriving it from Italy.

Voyage to the Hebrides, p. 30.

"Neither of theſe inſtruments (the Highland and Lowland bag-pipes above deſcribed) were the invention of the Danes, or, as is commonly ſuppoſed, of any of the northern nations; for their ancient writers prove them to have been animated by the *clangor tubarum*. Notwithſtanding they have had their ſœck pipe long amongſt them, as their old ſongs prove, yet we cannot allow them the honour of inventing this melodious inſtrument, but muſt aſſert, that they borrowed it from the invaded Caledonians. We muſt ſtill go farther, and deprive even that ancient race of the credit; and derive its origin from the mild climate of Italy, perhaps from Greece.

"There is now in Rome a moſt beautiful bas relievo, a Grecian ſculpture of the higheſt antiquity, of a bag-piper playing on his inſtrument, exactly like a modern Highlander. The Greeks had their Ασκαύλης, or inſtrument, compoſed of a pipe and blown-up ſkin: the Romans in all probability borrowed it from them, and introduced it among their ſwains, who ſtill uſe it under the names of *piva* and *cornu-muſa*.

"That maſter of muſic, Nero, uſed one; and had not the empire been ſo ſuddenly deprived of that great artiſt, he would (as he graciouſly declared his intention) have treated the people with a concert, and among other curious inſtruments, would have introduced the *utricularius* or bag-pipe. Nero periſhed; but the figure of the inſtrument is preſerved on one of his coins, but highly improved by that great maſter: it has the bag and two of the vulgar pipes; but was blown with a bellows like an organ, and had on one ſide a row of nine unequal pipes, reſembling the ſyrinx of the god Pan. The bag-pipe, in the unimproved ſtate, is alſo repreſented in an ancient ſculpture; and appears to have had two long pipes or drones, and a ſingle ſhort pipe for the fingers. Tradition ſays, that the kind played on by the mouth was introduced by the Danes; as theirs was wind-muſic, we will admit that they might have made improvement, but more we cannot allow: they were ſkilled in the uſe of the trumpet; the Highlanders in the piohb, or bag-pipe.

Non tuba in uſu illis, conjuncta at tibia in utrem
*Dat belli ſignum, et martem vocat horrida in arma**."

* *Melvini Topogr. Scot.*

The bag-pipe appears to have been an inſtrument of great antiquity in Ireland, though it is uncertain whence they derived it. Mr Pennant, by means of an antique found at Richborough in Kent, has determined that the bag-pipe was introduced at a very early period into Britain; whence it is probable that both Iriſh and Danes might borrow the inſtrument from the Caledonians with whom they had ſuch frequent intercourſe. Ariſtides Quintilianus informs us, that it prevailed in the highlands in very early ages; and indeed the genius of the people ſeems to render the opinion highly probable. The attachment of that people to their muſic called *pibrachs* is almoſt incredible, and on ſome occaſions is ſaid to have produced effects little leſs marvellous than thoſe aſcribed to the ancient muſic. At the battle of Quebec in 1760, while the Britiſh troops were retreating in great diſorder, the general complained to a field officer in Frazer's regiment of the bad behaviour of his corps. "Sir (ſaid he with ſome warmth), you did very wrong in forbidding the pipers to play this morning: nothing encourages the Highlanders ſo much in the day of action. Nay, even now they would be of uſe."—"Let them blow like the devil, then (replies the general), if it will bring back the men." The pipers were then ordered to play a favourite martial air; and the Highlanders, the moment they heard the muſic, returned and formed with alacrity in the rear. In the late war in India, Sir Eyre Coote, aware of the attachment of the Highlanders to their favourite inſtrument, gave them 50l. to buy a pair of bag-pipes after the battle of Porto Nuovo.

Formerly there was a kind of college in the iſland of Skye, where the highland bag-pipe was taught; the teachers making uſe of pins ſtuck into the ground inſtead of muſical notes. This college, however, has been for ſome time entirely diſſolved, and the uſe of the Highland pipe become much leſs general than before. At laſt a ſociety of gentlemen, thinking it perhaps impolitic to allow the ancient martial muſic of the country to decline, reſolved to revive it by giving an annual prize to the beſt performers on the inſtrument. Theſe competitions were firſt held at Falkirk, but for a good number of years at Edinburgh; where the only ſurviving member of the ancient college of Skye is now *profeſſor* of bag-pipe muſic.

The Lowland pipe, as has been already obſerved, is an inſtrument eſſentially different from the Highland pipe; it was reformed, and the muſic improved by George Mackie, who is ſaid to have attended the college of Skye ſeven years. He had before been the beſt performer on that inſtrument in that part of the country where he lived: but, while attending the college at Skye, he adapted the graces of the Highland muſic to the Lowland pipe. Upon his return, he was heard with aſtoniſhment and admiration; but unluckily, not being able to commit his improvements to writing, and indeed the nature of the inſtrument ſcarcely admitting of it, the knowledge of this kind of muſic hath continued to decay ever ſince, and will probably ſoon wear out altogether. What contributes much to this is, that bag-pipers, not content with the natural nine notes which their inſtrument can play eaſily, force it to play tunes requiring higher notes, which diſorders the whole inſtrument in ſuch a manner as to produce the moſt horrid diſcords; and this practice brings, though undeſervedly, the inſtrument itſelf into contempt.

BAGUETTE, in *Architecture*, a ſmall round moulding, leſs than an aſtragal, and ſo called from the reſemblance it bears to a ring.

BAHAMA, or LUCAYA, ISLANDS, are the eaſtermoſt of the Antilles, lying in the Atlantic ocean. They are ſituated to the ſouth of Carolina, between 22 and 27 degrees N. Lat. and 73 and 81 degrees W. Long. They extend along the coaſt of Florida quite down to the iſle of Cuba, and are ſaid to be 500 in number, ſome of them only bare rocks; but twelve of them are large, fertile, and in nothing different from the ſoil of Carolina: all are, however, uninhabited except Providence, which is 200 miles eaſt of the Floridas; though ſome others are larger and more fertile, on which the Engliſh have plantations. Between them and the continent of Florida is the gulf of Bahama, or Florida, through which the Spaniſh galeons ſail in their paſſage to Europe.

Theſe iſlands are the firſt fruits of Columbus's diſcoveries; but they were not known to the Engliſh till 1667, when Captain Seyle, being driven among them in his paſſage to Carolina, gave his name to one of them; and being a ſecond time driven upon it, gave it the name of *Providence*. The Engliſh, obſerving the advantageous ſituation of theſe iſlands for being a check on the French and Spaniards, attempted to ſettle them in the reign of Charles II. Some unlucky accidents prevented this ſettlement from being of any advantage; and the iſle of Providence became an harbour for the bucaniers or pirates, who for a long time infeſted the American navigation. This obliged the government in 1718 to ſend out Captain Woodes Rogers with a fleet to diſlodge the pirates, and for making a ſettlement. This the captain effected; a fort was erected, and an independent company was ſtationed in the iſland. Ever ſince this laſt ſettlement theſe iſlands have been improving, though they advance but ſlowly. In time of war, people gain conſiderably by the prizes condemned there; and at all times by the wrecks, which are frequent in this labyrinth of rocks and ſhelves. The Spaniards and Americans captured theſe iſlands during the laſt war; but they were retaken by a detachment from St Auguſtine, April 7. 1783. Cotton has been introduced into the Bahamas, where it is now ſucceſsfully cultivated. The quantity exported in 1792 was 5047 bales which amounted to 1,162,822 pounds.

BAHAR, or BARRE, in *Commerce*, weights uſed in ſeveral places in the Eaſt Indies.

There are two of theſe weights; one the great bahar, with which they weigh pepper, cloves, nutmegs, ginger, &c. and contains 550 pounds of Portugal, or about 524lb. 9oz. avoirdupois weight. With the little bahar, they weigh quickſilver, vermilion, ivory, ſilk, &c. It contains about 437lb. 9oz. avoirdupois weight.

BAHAREN, an iſland in the Perſian gulf, ſituated in E. Long. 50. 0. N. Lat. 26. 0. This iſland is chiefly remarkable for its pearl-fiſhery, and has often changed its maſters. It fell with Ormus under the dominion of the Portugueſe, was again reſtored to Perſia by Thamas Khouli Kan; and after his death the confuſion into which his empire was thrown, gave an opportunity to an enterpriſing and ambitious Arab of taking poſſeſſion of the iſland, where he ſtill maintains his authority. Baharen was famous for its pearl-fiſhery even at the time when pearls were found at Ormus, Karek, Kaſhy, and other places in the Perſian gulf: but it is now become of much greater conſequence; all the other banks having been exhauſted, while this has ſuffered no ſenſible diminution. The time of fiſhing begins in April, and ends in October. It is confined to a tract four or five leagues in breadth. The pearls taken at Baharen, though not ſo white as thoſe of Ceylon or Japan, are much larger than thoſe of the former place, and more regularly ſhaped than thoſe of the latter. They have a yellowiſh colour; but have alſo this good quality, that they preſerve their golden hue, whereas the whiter kind loſe much of their luſtre by keeping, eſpecially in hot countries. The annual revenue from the Baharen pearl fiſhery is computed at about 157,500l. The greateſt part of the pearls that are uneven are carried to Conſtantinople and other ports of Turkey, where the larger go to compoſe ornaments for head-dreſſes, and the ſmaller are uſed in embroideries. The perfect pearls muſt be reſerved for Surat, whence they are diſtributed through all Indoſtan.

BAHI, a province of Luçon or Manilla, one of the Philippine iſlands in the Eaſt Indies, belonging to the Spaniards. It is remarkable for producing excellent betel, which the inhabitants, Spaniards as well as natives, perpetually chew from morning till night. It is alſo the place where moſt of the ſhips are built. But the natives ſuffer much from this work; ſeveral hundreds of them being conſtantly employed in it, on the mountains, or at the port of Cavite. The king allows theſe labourers a piece-of-eight per month, with a ſufficient quantity of rice. The whole province contains about 6000 tributary natives.

BAHIA, DE TODOS LOS SANCTOS, a province of Braſil in South America, belonging to the Portugueſe, and the richeſt in the whole country; but unhappily the air and climate do not correſpond with other natural advantages; yet ſo fertile is the province in ſugar and other commercial articles, that the Portugueſe flock hither not only as it is the ſeat of affluence, but alſo of pleaſure and grandeur. The capital, called *St Salvador*, or *Cividad de Bahia*, is populous, magnificent, and beyond compariſon the moſt gay and opulent city in Braſil. It ſtands on a bay in S. Lat. 12. 11. is ſtrong by nature, well fortified, and always defended by a numerous garriſon. It contains 12,000 or 14,000 Portugueſe, and about three times as many negroes, beſides people of different nations who chooſe to reſide in that city.

BAHIR, a Hebrew term ſignifying *famous* or *illuſtrious;* but particularly uſed for a book of the Jews, treating of the profound myſteries of the cabbala, being the moſt ancient of the Rabbinical works.

BAHUS, a ſtrong town of Sweden, and capital of a government of the ſame name, ſeated on a rock in a ſmall iſland, in E. Long. 11. 10. N. Lat. 57. 52.

BAJA, BAYJAH, or BEGIA, a town of the kingdom of Tunis in Africa, ſuppoſed to be the ancient *Vacca* of Salluſt, and *Oppidum Vaggenſe* of Pliny. It

Baja, Baiæ.

was formerly, and ftill continues to be, a place of great trade, and the chief market of the kingdom for corn; of which the adjacent territories produce fuch abundance, that they can fupply more than the whole kingdom with it; and the Tunifians fay, that if there was in the kingdom fuch another town as this for plenty of corn, it would become as cheap as fand. Here is alfo a great annual fair, to which the moft diftant Arabian tribes refort with their families and flocks. Notwithftanding all this, however, the inhabitants are very poor, and great part of the land about the town remains uncultivated, through the cruel exactions of the government, and the frequent incurfions of the Arabs, who are very powerful in thefe parts. The town ftands on the declivity of a hill on the road to Conftantina, about 10 leagues from the northern coaft, and 36 fouth-weft from Tunis; and hath the convenience of being well watered. On the higheft part is a citadel that commands the whole place, but is now of no great ftrength. The walls were raifed out of the ruins of the ancient Vacca, and have fome ancient infcriptions.

Baja, a populous town of Hungary, feated on the Danube, in E. Long. 19. 50. N. Lat. 46. 40.

BAIÆ, an ancient village of Campania in Italy, between the promontory of Mifenum and Puteoli, on the Sinus Baianus; famous for its natural hot baths, which ferved the wealthier Romans for the purpofes both of medicine and pleafure.—The variety of thofe baths, the foftnefs of its climate, and the beauty of its landfcape, captivated the minds of opulent nobles, whofe paffion for bathing knew no bounds. Abundance of linen, and difufe of ointments, render the practice lefs neceffary in modern life; but the ancients performed no exercife, engaged in no ftudy, without previous ablutions, which at Rome required an enormous expence in aqueducts, ftoves, and attendants: a place therefore, where waters naturally heated to every degree of warmth bubbled fpontaneoufly out of the ground, in the pleafanteft of all fituations, was fuch a treafure as could not be overlooked. Baiæ was this place in the higheft perfection; its eafy communication with Rome was alfo a point of great weight. Hither at firft retired for a temporary relaxation the mighty rulers of the world, to ftring anew their nerves and revive their fpirits, fatigued with bloody campaigns and civil contefts. Their habitations were fmall and modeft: but foon increafing luxury added palace to palace with fuch expedition and fumptuofity, that ground was wanting for the vaft demand: enterprifing architects, fupported by infinite wealth, carried their foundations into the fea, and drove that element back from its ancient limits: it has fince taken ample revenge, and recovered much more than it ever loft. From being a place of refort for a feafon, Baiæ now grew up to a permanent city: whoever found himfelf difqualified by age, or infirmity, for fuftaining any longer an active part on the political theatre; whoever, from an indolent difpofition, fought a place where the pleafures of a town were combined with the fweets of a rural life; whoever wifhed to withdraw from the dangerous neighbourhood of a court, and the baneful eye of informers, flocked hither to enjoy life untainted with fear and trouble. Such affluence of wealthy inhabitants rendered Baiæ as much a miracle of art as it was before of nature; its fplendour may be inferred from its innumerable ruins, heaps of marbles, mofaics, ftucco, and other precious fragments of tafte.—It flourifhed in full glory down to the days of Theodoric the Goth; but the deftruction of thefe enchanted palaces followed quickly upon the irruption of the northern conquerors, who overturned the Roman fyftem, facked and burnt all before them, and deftroyed or difperfed the whole race of nobility. Lofs of fortune left the Romans neither the means, nor indeed the thought, of fupporting fuch expenfive eftablifhments, which can only be enjoyed in perfection during peace and profperity. No fooner had opulence withdrawn her hand, than the unbridled fea rufhed back upon its old domain; moles and buttreffes were torn afunder and wafhed away; whole promontories, with the proud towers that once crowned their brows, were undermined and tumbled headlong into the deep, where, many feet below the furface, pavements of ftreets, foundations of houfes, and maffes of walls, may ftill be defcried. Internal commotions of the earth contributed alfo largely to this general devaftation; mephitic vapours and ftagnated waters have converted this favourite feat of health into the den of peftilence, at leaft during the eftival heats: yet Baiæ in its ruined ftate, and ftripped of all its ornaments, ftill prefents many beautiful and ftriking fubjects for the pencil. E. Long. 14. 45. N. Lat. 41. 6.

Swinburne's Sicily.

Bajador ‖ Bajazet.

BAJADOR, a cape on the weft coaft of Africa, fouth of the Canary iflands. W. Long. 15. 20. N. Lat. 27. 0.

BAIANUS SINUS, a bay fo called from *Baiæ*, (Suetonius); *Portus Baiarum*, (Pliny); which was enlarged by Auguftus, by giving entrance to the fea into the Lacus Lucrinus, and Averni, ordering it to be called *Portus Julius apud Baias*, (Suetonius). We alfo read *Baianus Lacus* in Tacitus, which fome interpret the *Lucrinus*. The modern name is *Golfo di Pozzuolo*. From the higheft point that forms the bay, a large caftle commands the road, where foreign fhips of war ufually ride at anchor, the harbour of Naples not being fpacious enough for the reception of a fleet: here they enjoy good fhelter, watering, and victualling; but in fummer rifk the health of their crews, on account of the unwholefomnefs of the air.

BAJAZET I. fultan of the Turks, a renowned warrior but a tyrant, was conquered by Tamerlane, and expofed by him in an iron cage; the fate he had deftined (it is faid) for his adverfary if he had been the victor.

The iron cage, however, fo long and fo often repeated as a moral leffon, has been rejected as a fable by modern writers, who fmile at the vulgar credulity. They appeal to the Perfian hiftory of Shercfeddin Ali, of which a French verfion has been given, and from which Mr Gibbon has collected the following more fpecious narrative of this memorable tranfaction. "No fooner was Timour informed that the captive Ottoman was at the door of his tent, than he gracioufly ftepped forwards to receive him, feated him by his fide, and mingled with juft reproaches a foothing pity for his rank and misfortune. "Alas! (faid the emperor,) the decree of fate is now accomplifhed by your own fault: it is the web which you have woven, the thorns of the tree which yourfelf have planted. I wifhed to fpare, and even to affift, the champion of the Moflems; you braved our threats, you defpifed our friendſhip; you forced us to enter your kingdom with our invincible armies. Behold the event. Had you vanquiſhed, I am not ignorant of the fate which you reſerved for myſelf and my troops. But I diſdain to retaliate: your life and honour are ſecure; and I ſhall expreſs my gratitude to God by my clemency to man." The royal captive ſhowed ſome ſigns of repentance, accepted the humiliation of a robe of honour, and embraced with tears his ſon Mouſa, who, at his requeſt, was ſought and found among the captives of the field. The Ottoman princes were lodged in a ſplendid pavilion; and the reſpect of the guards could be ſurpaſſed only by their vigilance. On the arrival of the haram from Bourſa, Timour reſtored the queen Deſpina and her daughter to their father and huſband; but he piouſly required, that the Servian princeſs, who had hitherto been indulged in the profeſſion of Chriſtianity, ſhould embrace without delay the religion of the prophet. In the feaſt of victory, to which Bajazet was invited, the Mogul emperor placed a crown on his head and a ſceptre in his hand, with a ſolemn aſſurance of reſtoring him with an increaſe of glory to the throne of his anceſtors. But the effect of this promiſe was diſappointed by the ſultan's untimely death: amidſt the care of the moſt ſkilful phyſicians, he expired of an apoplexy at Akſhehr, the Antioch of Piſidia, about nine months after his defeat. The victor dropped a tear over his grave; his body, with royal pomp, was conveyed to the mauſoleum which he had erected at Bourſa; and his ſon Mouſa, after receiving a rich preſent of gold and jewels, of horſes and arms, was inveſted by a patent in red ink with the kingdom of Anatolia.

"Such is the portrait of a generous conqueror, which has been extracted from his own memorials, and dedicated to his ſon and grandſon, 19 years after his deceaſe; and, at a time when the truth was remembered by thouſands, a manifeſt falſehood would have implied a ſatire on his real conduct. On the other hand, of the harſh and ignominious treatment of Bajazet there is alſo a variety of evidence. The Turkiſh annals in particular, which have been conſulted or tranſcribed by Leunclavius, Pocock, and Cantemir, unanimouſly deplore the captivity of the iron cage; and ſome credit may be allowed to national hiſtorians, who cannot ſtigmatize the Tartar without uncovering the ſhame of their king and country." From theſe oppoſite premiſes, Mr Gibbon thinks a fair and moderate concluſion may be deduced. He is ſatiſfied that Sherefeddin Ali has faithfully deſcribed the firſt oſtentatious interview, in which the conqueror, whoſe ſpirits were harmonized by ſucceſs, affected the character of generoſity. But his mind was inſenſibly alienated by the unſeaſonable arrogance of Bajazet; the complaints of his enemies, the Anatolian princes, were juſt and vehement; and Timour betrayed a deſign of leading his royal captive in triumph to Samarcand. An attempt to facilitate his eſcape by digging a mine under the tent, provoked the Mogul emperor to impoſe a harſher reſtraint; and in his perpetual marches, an iron cage on a waggon might be invented, not as a wanton inſult, but as a rigorous precaution. Timour had read in ſome fabulous hiſtory a ſimilar treatment of one of his predeceſſors, a king of Perſia; and Bajazet was condemned to repreſent the perſon and expiate the guilt of the Roman Cæſar. But the ſtrength of his mind and body fainted under the trial, and his premature death might without injuſtice be aſcribed to the ſeverity of Timour. He warred not, however, with the dead; a tear and a ſepulchre were all that he could beſtow on a captive who was delivered from his power; and if Mouſa, the ſon of Bajazet, was permitted to reign over the ruins of Bourſa, the greateſt part of the province of Anatolia had been reſtored by the conqueror to their lawful ſovereigns.

BAIKAL, a great lake in Siberia, lying between 52 and 55 degrees of north latitude. It is reckoned to be 500 werſts in length; but only 20 or 30 broad, and in ſome places not above 15. It is environed on all ſides by high mountains. In one part of it, which lies near the river Barguſian, it throws up an inflammable ſulphureous liquid called *maltha*, which the people of the adjacent country burn in their lamps. There are likewiſe ſeveral ſulphureous ſprings near this lake. Its water at a diſtance appears of a ſea-green colour: it is freſh; and ſo clear, that objects may be ſeen in it ſeveral fathoms deep. It does not begin to freeze till near the latter end of December, and thaws again about the beginning of May: from which time till September, a ſhip is ſeldom known to be wrecked on it; but by the high winds which then blow, many ſhipwrecks happen. This lake is called by the neighbouring people *Swiatoie More*, or the *Holy Lake;* and they imagine, that when ſtorms happen on it, they will be preſerved from all danger by complimenting it with the title of *ſea*. When it is frozen over, people travel upon it in the road to China; but they muſt be very ſharp ſhod, otherwiſe they cannot ſtand upon the ice, which is exceedingly ſmooth. Notwithſtanding that the ice on this lake is ſometimes two ells thick, there are ſome open places in it to which tempeſtuous winds will often drive thoſe who are croſſing it; in which caſe they are irrecoverably loſt. The camels that paſs along have a particular kind of ſhoes ſharp at bottom, and the oxen have ſharp irons driven through their hoofs, without which it would be impoſſible for them to paſs. Here are plenty of large ſturgeon and pike; with many ſeals of the black, but none of the ſpotted, kind. It contains ſeveral iſlands; and the borders are frequented by black ſables and civet-cats.

BAIL, BALLIUM, (from the French *bailler*, which comes of the Greek βαλλειν, and ſignifies to deliver into hands), is uſed in our common law for the freeing or ſetting at liberty of one arreſted or impriſoned upon any action, either civil or criminal, on ſurety taken for his appearance at a day and place certain.

The reaſon why it is called *bail*, is becauſe by this means the party reſtrained is delivered into the hands of thoſe that bind themſelves for his forthcoming, in order to a ſafe-keeping or protection from priſon; and the end of bail is to ſatisfy the condemnation and coſts, or render the defendant to priſon.

With reſpect to bail in civil caſes, it is to be obſerved, that there is both common and ſpecial bail. Common bail is an action of ſmall concernment, being called *common*, becauſe any ſureties in that caſe are taken; whereas in cauſes of great weight, as actions upon bonds, or ſpeciality, &c. where the debt amounts to 10l. *ſpecial* bail or ſurety muſt be taken, fuch as fubfidy men at leaft, and they according to the value.

The commitment of a perfon being only for fafe cuftody, wherever bail will anfwer the fame intention, it ought to be taken, as in moft of the inferior crimes: but in felonies, and other offences of a capital nature, no bail can be a fecurity equivalent to the actual cuftody of the perfon. For what is there that a man may not be induced to forfeit to fave his own life? and what fatisfaction or indemnity is it to the public, to feize the effects of them who have bailed a murderer, if the murderer himfelf be fuffered to efcape with impunity? Upon a principle fimilar to which, the Athenian magiftrates, when they took a folemn oath never to keep a citizen in bonds that could give three fureties of the fame quality with himfelf, did it with an exception to fuch as had embezzled the public money, or been guilty of treafonable practices.

Bail may be taken either in court, or, in fome particular cafes, by the fheriff or other magiftrate; but moftly ufed by the juftices of the peace. To refufe or delay to bail any perfon bailable, is an offence againft the liberty of the fubject, in any magiftrate, by the common law; as well as by the ftatute Weftm. 1. 3 Edw. I. c. 15. and the *habeas corpus* act, 31 Car. II. c. 2. And, left the intention of the law fhould be fruftrated by the juftices requiring bail to a greater amount than the nature of the cafe demands, it is exprefsly declared by ftatute 1 W. and M. ft. 2. c. 1. that exceffive bail ought not to be required; though what bail fhall be called *exceffive*, muft be left to the courts, on confidering the circumftances of the cafe, to determine. And on the other hand, if the magiftrate takes infufficient bail he is liable to be fined, if the criminal doth not appear.

In *civil* cafes, every defendant is bailable. But it is otherwife in

Criminal matters. Regularly, in all offences, either againft the common law or act of parliament, that are below felony, the offender ought to be admitted to bail unlefs it be prohibited by fome fpecial act of parliament.—By the ancient common law, before and fince the Conqueft, all felonies were bailable, till murder was excepted by ftatute: fo that perfons might be admitted to bail almoft in every cafe. But the ftatute Weft. 1. 3 Edw. I. c. 15. takes away the power of bailing in treafon, and in divers inftances of felony. The ftatutes 23 Hen. VI. c. 9. and 1 and 2 Ph. and Mar. c. 13. gave farther regulations in this matter: and upon the whole we may collect, that no juftices of the peace can bail, 1. Upon an accufation of treafon: nor, 2. Of murder: nor 3. In cafe of manflaughter, if the prifoner be clearly the flayer, and not barely fufpected to be fo; or if any indictment be found againft him; nor, 4. Such as, being committed for felony, have broken prifon; becaufe it not only carries a prefumption of guilt, but is alfo fuperadding one felony to another: 5. Perfons outlawed: 6. Such as have abjured the realm: 7. Perfons taken with the mainour, or in the fact of felony: 8. Perfons charged with arfon: 9. Excommunicated perfons, taken by writ *de excommunicato capiendo*: all which are clearly not admiffible to bail by the juftices. Others are of a dubious nature; as, 10. Thieves openly defamed and known: 11. Perfons charged with other felonies, or manifeft and enormous offences, not being of good fame: and, 12. Acceffories to felony, that labour under the fame want of reputation. Thefe feem to be in the difcretion of the juftices, whether bailable or not. The laft clafs are fuch as *muft* be bailed upon offering fufficient furety; as, 13. Perfons of good fame, charged with a bare fufpicion of manflaughter, or other infamous homicide: 14. Such perfons being charged with petit larceny or any felony, not before fpecified: or, 16. With being acceffory to any felony. Laftly, it is agreed, that the court of king's bench (or any judge thereof in time of vacation) may bail for any crime whatfoever, be it treafon, murder, or any other offence, according to the circumftances of the cafe. And herein the wifdom of the law is very manifeft. To allow bail to be taken commonly for fuch enormous crimes, would greatly tend to elude the public juftice: and yet there are cafes, though they rarely happen, in which it would be hard and unjuft to confine a man in prifon, though accufed even of the greateft offence. The law has therefore provided one court, and only one, which has a difcretionary power of bailing in any cafe: except only, even to this high jurifdiction, and of courfe to all inferior ones, fuch perfons as are committed by either houfe of parliament, fo long as the feffion lafts; or fuch as are committed for contempts by any of the king's fuperior courts of juftice. See Law.

Clerk of the Bails, is an officer belonging to the court of the king's bench: he files the bail-pieces taken in that court, and attends for that purpofe.

Bail, or Bale, in the fea-language. The feamen call throwing the water by hand out of the fhip's or boat's hold, *bailing*. They alfo call thofe hoops that bear up the tilt of a boat, its *bails*.

BAILIE, in *Scots Law*, a judge anciently appointed by the king over fuch lands not erected into a regality as happened to fall to the crown by forfeiture or otherwife, now abolifhed. It is alfo the name of a magiftrate in royal boroughs, and of the judge appointed by a baron over lands erected into a barony. See Law.

BAILIFF, (*ballivus*), from the French word *bayliff*, that is, *præfectus provinciæ*; and as the names, fo the office itfelf was anfwerable to that of France; where there are eight parliaments, which are high courts from whence there lies no appeal, and within the precincts of the feveral parts of that kingdom which belong to each parliament there are feveral provinces to which juftice is adminiftered by certain officers called *bailiffs*: and in England there are feveral counties in which juftice hath been adminiftered to the inhabitants by the officer who is now called *fheriff* or *vifcount* (one of which names defcends from the Saxons, the other from the Normans); and though the fheriff is not called *bailiff*, yet it is probable that was one of his names alfo, becaufe the county is often called *balliva*. And in the ftatute of Magna Charta, cap. 28. and 14 Ed. III. c. 9. the word *bailiff* feems to comprife as well fheriffs as bailiffs of hundreds. As the realm is divided into counties, fo every county is divided into hundreds; within which in ancient times the people had juftice miniftered to them by the officers of every hundred. But now the hundred courts, except certain franchifes, are fwallowed in the county-courts; and the bailiff's bailiff's name and office is grown into contempt, they being generally officers to ſerve writs, &c. within their liberties. Though, in other reſpects, the name is ſtill in good eſteem: for the chief magiſtrates in divers towns are called *bailiffs* or *bailies;* and ſometimes the perſons to whom the king's caſtles are committed are termed *bailiffs*, as the *bailiff of Dover Caſtle*, &c.

Of the ordinary bailiffs there are ſeveral ſorts, viz. ſheriff's bailiffs, bailiffs of liberties, &c.

Sheriff's bailiffs, or ſheriff's officers, are either bailiffs of hundreds, or ſpecial bailiffs. Bailiffs of hundreds are officers appointed over thoſe reſpective diſtricts by the ſheriffs, to collect fines therein; to ſummon juries; to attend the judges and juſtices at the aſſiſes and quarter-ſeſſions; and alſo to execute writs and proceſs in the ſeveral hundreds. But as theſe are generally plain men, and not thoroughly ſkilful in this latter part of their office, that of ſerving writs, and making arreſts and executions, it is now uſual to join ſpecial bailiffs with them; who are generally mean perſons employed by the ſheriffs on account only of their adroitneſs and dexterity in hunting and ſeizing of their prey.

Bailiffs of liberties are thoſe bailiffs who are appointed by every lord within his liberty, to execute proceſs, and do ſuch offices therein as the bailiff errant doth at large in the county; but bailiffs errant or itinerant, to go up and down the county to ſerve proceſs, are out of uſe.

There are alſo bailiffs of foreſts, and bailiffs of manors, who direct huſbandry, fell trees, gather rents, pay quit-rents, &c.

*Water-*BAILIFF, an officer appointed in all port-towns, for the ſearching of ſhips, gathering the toll for anchorage, &c. and arreſting perſons for debt, &c. on the water.

BAILII, DAVID, painter of perſpective views and portraits, was the ſon of Peter Bailii, an artiſt of ſome note; and was born at Leyden in 1584. From his father he learned to draw and deſign; but he was afterwards placed under the care of Adrian Verburg, and continued with him for ſome time; and when he quitted that maſter, he ſtudied to much greater advantage with Cornelius Vandervoort, an excellent portrait-painter, and with him he ſpent about ſix years. As Vandervoort poſſeſſed many capital paintings of ſome great maſters, Bailii, for his own improvement, copied them with critical care and obſervation; and particularly copied one perſpective view of the inſide of a church, originally painted by Stenwyck, which he finiſhed with ſuch accuracy, that even Stenwyck himſelf could ſcarce determine which was the original, or which the copy, when both were placed before him. He travelled through ſeveral parts of Italy to ſee the works of the celebrated maſters of that country, and for a few years reſided at Rome; and abroad, as well as in his own country, the correctneſs of his drawing, and the delicate handling and finiſhing of his pictures, procured him employment, admirers, and friends. In the latter part of his life he diſcontinued painting, and only drew portraits on vellum with a pen, which he heightened with black lead, and gave them wonderful force and roundneſs. He died in 1638.

BAILIWICK, that liberty which is exempted from the ſheriff of the county; over which liberty the lord thereof appoints his own bailiff, with the like power within his precinct as an under ſheriff exerciſes under the ſheriff of the county: Or it ſignifies the precinct of a bailiff, or the place within which his juriſdiction is terminated.

BAILLET, ADRIAN, a very learned French writer and critic, born in 1649 at the village of Neuville near Beauvais in Picardy. His parents were too poor to give him a proper education, which however he obtained by the favour of the biſhop of Beauvais, who afterwards preſented him with a ſmall vicarage. In 1680 he was appointed librarian to M. de Lamoignon, advocate-general to the parliament of Paris; of whoſe library he made a copious index in 35 vols. folio, all written with his own hand. He died in 1706, after writing many works, the principal of which are, *A Hiſtory of Holland from* 1609, *to the peace of Nimeguen in* 1679, 4 vols 12mo; *Lives of the Saints*, 3 vols folio, which he profeſſed to have purged from fables; *Jugemens des Sçavans*, which he extended to 9 vols 12mo; and *The life of Des Cartes*, 2 vols 4to, which he abridged, and reduced to one vol. 12mo.

BAILLEUL, a town of France, in the department of the North, formerly very ſtrong, but now without any fortifications. It has been ſeveral times burnt by accident, and contains now only about 500 houſes. E. Long. 2. 55. N. Lat. 40. 35.

BAILLY, JEAN SYLVAIN, a celebrated philoſopher and aſtronomer, was born at Paris on the 15th September 1736. He was originally intended for the profeſſion of painting, which his family had purſued for ſeveral generations, and he even had made ſome progreſs in the art. But the bias of his mind leaned too much to literary purſuits, eſpecially to poetry, and works of imagination, to permit him to give that application which is neceſſary to ſecure ſucceſs and eminence in any profeſſion.

The friends of Bailly, who had witneſſed the early dawn of his genius, ſaw that it was equally fitted to appear with advantage in the ſtudy of polite literature, or to ſhine in the walks of ſcience; and recommended the latter chiefly to his attention. His acquaintance with La Caille the celebrated geometer commenced, and this at once decided the object of his ſtudies, which were now almoſt entirely devoted to ſcientific inveſtigations. The firſt of his labours was the calculation of the comet which appeared in the year 1759. In January 1763, he was admitted a member of the Academy of Sciences; and in the ſame year he publiſhed a reduction of the obſervations made by La Caille in 1760 and 1761 on the zodiacal ſtars, an elaborate compilation, and of extenſive utility. His attention was afterwards directed to the conſideration of the theory of Jupiter's ſatellites. La Grange, who now promiſed to be the firſt mathematician in Europe, was the formidable rival of Bailly in the competition for this prize queſtion in 1764. The reſults of his inveſtigations were collected into a treatiſe, which alſo contained the hiſtory of that part of aſtronomy, and were publiſhed in 1766. In 1771 appeared his intereſting and important memoir on the Light of the ſatellites, which was marked with a degree of preciſion and accuracy, till that time altogether unknown in the obſervations of their eclipſes.

The ſtudies of Bailly were not entirely limited to the cultivation of abſtract ſcience, or to profound phyſical

Bailly. fical ſpeculations; his genius ſhone with equal luſtre in thoſe departments of literature which require the rare talent of nice diſcrimination of characters, and no common power of eloquence, to reach excellence. The eloges which he compoſed for Charles V. Corneille, Leibnitz, Moliere, Cook, La Caille, and Greſſet, were univerſally admired as valuable ſpecimens of fine writing, and added much to his reputation. The diſtinguiſhed place of ſecretary of the Academy of Sciences became vacant in 1771; and, ſupported by the patronage and influence of Buffon, he offered himſelf a candidate. But here he was unſucceſsful. Condorcet, who was then riſing into reputation, and was ſupported by the active influence of D'Alembert, was preferred to the office.

In the year 1775, he publiſhed at Paris the firſt volume of the "Hiſtory of Ancient Aſtronomy." The ſecond volume of the ſame work appeared in 1787. In 1779 he gave to the world his "Hiſtory of Modern Aſtronomy," from the foundation of the Alexandrian ſchool to the preſent age. Theſe works are of ineſtimable value, diſtinguiſhed by animated deſcription, luminous narration, and intereſting detail. He alſo publiſhed a work entitled, "Letters on the Origin of the Sciences, and of the People of Aſia;" which was afterwards followed by another ſeries of "Letters on the Atlantis of Plato, and the Ancient Hiſtory of Aſia," as a continuation of the ſame work. Theſe volumes were addreſſed to Voltaire, with whom he had commenced an ingenious correſpondence and diſcuſſion on this curious ſubject. The coincidence of his opinions with thoſe of Buffon in points reſpecting ſome of the favourite theories of the latter, brought him into an intimate acquaintance and cloſe friendſhip with that celebrated naturaliſt, which, however, declined and was entirely diſſolved, in conſequence of the oppoſition which Bailly made to the election of the Abbé Maury into the French Academy. Bailly had been choſen ſecretary of this academy in 1784; and in the following year he was admitted into the Academy of Inſcriptions and Belles Lettres. This was the only inſtance, ſince the time of Fontenelle, of the ſame perſon being at once a member of all the three academies.

In the year 1784 he was nominated one of the commiſſion to inveſtigate the nature of the animal magnetiſm of Meſmer, which was practiſed by Deſlon; and he drew up an elegant report, which was preſented to the Academy of Sciences. This report, which was ſoon afterwards tranſlated into Engliſh, not only marked the acuteneſs and diſcernment of the author, and contained the moſt ſatisfactory and deciſive evidence with regard to its object, but may be held up as an excellent model of imitation for thoſe who are engaged in ſimilar inveſtigations. In developing the phyſical effects produced by moral cauſes, it is of the greateſt value; and it is particularly intereſting when we conſider the political influence which cauſes of this nature have impoſed on the general opinions of ſociety, and even on the deſtiny of nations.

Hitherto we have contemplated Bailly in the ſhades of retirement, and in the calm undiſturbed retreats of philoſophy, employing the energy of a vigorous and comprehenſive mind in the profound reſearches of phyſical truth: we are now to follow him in his political career, and behold him ſtruggling with the adverſe intereſts of party faction, and contending with the unbridled fury of a lawleſs mob, in defence of the rights of a people whoſe minds were not prepared to underſtand, and whoſe habits were not yet formed to enjoy, the bleſſings of rational liberty. He was one of the firſt and moſt zealous promoters of the revolution in France,—a revolution which not only aſtoniſhed and convulſed all Europe, but of which the immediate conſequences to themſelves, and to their country, were neither foreſeen nor imagined by thoſe who embarked in it, nor can its ultimate effects even at the preſent period be appreciated or conjectured,—a revolution which holds out an awful leſſon to the leaders of popular faction to curb and repreſs, rather than to excite and encourage, that ſpirit of tumult and diſorder among a people thrown looſe from the neceſſary reſtraints of law, which burſts forth with ungovernable fury, and at laſt involves all in one general ruin. In the part which he acted in this bloody ſtruggle, Bailly has had the good fortune to be well ſpoken of by oppoſite parties. He has not been charged with want of integrity or ſelfiſh deſigns in any part of his conduct; but actuated by a miſguided zeal, and dazzled with the proſpect of freedom which the warmth of imagination held out, he raſhly ſtepped forward in a cauſe which he eſpouſed with enthuſiaſm, and ſupported with his utmoſt exertions. But in that cauſe he fell a ſacrifice to the unrelenting ſpirit of violence and party faction which had been rouſed, and which could neither be ſubdued nor regulated. When the ſtates-general of France were aſſembled in 1789, he was elected a deputy to the *Tiers Etat*, was afterwards choſen preſident; and when the national aſſembly was conſtituted, he continued in the chair, and was preſident at the time that the king's proclamation was iſſued ordering them to diſperſe. During the ſtruggle which took place between the popular part of the aſſemblies and the court, Bailly was among the moſt forward in aſſerting thoſe popular rights which were then new in France; and he dictated the famous oath to the members of the *Tiers Etat*, "to reſiſt tyrants and tyranny, and never to ſeparate till they had obtained a free conſtitution." On the 14th of July following, the day on which the Baſtile was ſtormed and taken by the people, he was appointed with univerſal conſent, mayor of Paris. In this high office, he is allowed to have diſcharged the arduous and difficult duties of it with great integrity, courage, and moderation. And while he held this conſpicuous ſituation, he was a powerful agent in promoting the various meaſures by which the popular party prevailed over that of the court; and for this, and various other popular actions, he obtained a high degree of favour among the people. But the tide of public opinion now ſwelled beyond all bounds; no reſtraint could oppoſe its violent courſe. The multitude, unſhackled by the fetters of deſpotiſm, fond of novelty, and with enthuſiaſtic and unſettled notions of freedom, daily panting for change, could bear no oppoſition. Bailly, who perhaps now ſaw when it was too late the general diſpoſition of the people to anarchy, ſtill wiſhed the laws to be reſpected, and hoped by their vigorous execution to reſtore and preſerve tranquillity. He ordered ſome deputies from the military inſurgents at Nancy to be arreſted, and he firmly oppoſed the raſh proceedings of Marat and Hubert; he became

came a member of a less promiscuous club than that of the Jacobins; and exerted himself strongly to persuade the populace to permit the king and royal family to depart to St Cloud. By these measures, which were little relished by a frantic and lawless people, he lost their confidence and favour. But what finally destroyed his popularity, was the tumultuous meeting of the populace on the 17th of July 1791, to demand the abolition of monarchy, when, being called by the national assembly to disperse the mob, who had assaulted the soldiery, he ordered the latter to fire, by which 40 persons were killed and above 100 wounded. Thus become obnoxious to the people whom he had faithfully served, it was no longer desirable for him to hold his charge. He therefore resigned his office at the dissolution of the constituent assembly in the end of the year 1791. After this period he lived in retirement, having resumed his philosophical researches. But the times of bloody proscription approached, and he must fall a sacrifice to the ferocious vengeance of the tyrant who now bore unlimited sway. He was accordingly denounced as an enemy to the republic, apprehended and thrown into prison. He was arraigned before a sanguinary tribunal, summarily condemned to death as a conspirator, and was executed the day following, near the spot where he had given the order for the military to fire on the people. On the day of execution, his sufferings, which he bore with the utmost calmness and magnanimity, were studiously protracted. Instead of that sympathy and compassion which even the worst and the lowest criminal often experiences when he is about to expiate his offences with his life, he was treated by an incensed and barbarous populace, with the most ignominious indignity and cruelty. He wore the red shirt, or badge of conspiracy, and was placed in a cart, with his hands tied behind his back. During the whole time of his progress to the place of execution, the rain poured incessantly on his head. The populace as he passed threw mud at him, and cruelly insulted him with every kind of opprobrious language. It was found necessary to remove the guillotine from the place where it was first erected to firmer ground. During this time he was forced to get out of the cart, and walk round the field, to gratify more fully the implacable and unrelenting malice of the mob. When he was ascending the platform, a spectator who was near him, in a tone of insult exclaimed, "Bailly, you tremble:" "Yes (he instantly replied), but not with fear."

Thus perished Bailly in the 57th year of his age. In his person he was tall, and of a sedate but striking countenance. He possessed great firmness and decision of character, but far removed from sullenness or apathy. Few philosophers have been more distinguished in so many various departments of science and literature, or have acquired such deserved reputation. In his public stations, as well as in the retirement of domestic life, his integrity and disinterestedness remained pure and untainted. In the time of his magistracy he spent part of his fortune in relieving the wants of the poor. His wife, whom he married in 1787, survived him. She was the widow of Raymond Gaye, who had been his intimate friend 25 years.

BAILMENT, in *Law*, is a delivery of goods in

trust, upon a contract, expressed or implied, that the trust shall be faithfully executed on the part of the bailee. As if cloth be delivered, or (in our legal dialect) bailed, to a taylor to make a suit of clothes, he has it upon an implied contract to render it again when made, and that in a workmanly manner. If money or goods be delivered to a common carrier to convey from Oxford to London, or from Glasgow to Edinburgh, &c. he is under a contract in law to pay, or carry them to the person appointed. If a horse or other goods be delivered to an innkeeper or his servants, he is bound to keep them safely and restore them when his guest leaves the house. If a man takes in a horse, or other cattle, to graze and depasture in his grounds, which the law calls *agistment*, he takes them upon an implied contract to return them on demand to the owner. If a pawnbroker receives plate or jewels as a pledge or security for the repayment of money lent thereon at a day certain, he has them upon an express contract or condition to restore them if the pledger performs his part by redeeming them in due time; for the due execution of which contract, many useful regulations are made by statute 30 Geo. II. c. 24. And so, if a landlord distrains goods for rent, or a parish officer for taxes, these for a time are only a pledge in the hands of the distrainers; and they are bound by an implied contract in law to restore them on payment of the debt, duty and expences, before the time of sale; or when sold, to render back the overplus. If a friend delivers any thing to his friend to keep for him, the receiver is bound to restore it on demand: and it was formerly held, that in the mean time he was answerable for any damage or loss it might sustain, whether by accident or otherwise; unless he expressly undertook to keep it only with the same care as his own goods, and then he should not be answerable for theft or other accidents. But now the law seems to be settled on a much more rational footing; that such a general bailment will not charge the bailee with any loss, unless, it happens by gross neglect, which is construed to be an evidence of fraud: but if the bailee undertakes specially to keep the goods safely and securely, he is bound to answer all perils and damages that may befal them for want of the same care with which a prudent man would keep his own.

BAILO; thus they style at Constantinople the ambassador of the republic of Venice, who resides at the Porte. This minister, besides the political charge, acts there the part of a consul of Venice.

BAINBRIDGE, Dr John, an eminent physician and astronomer, born at Ashby de la Zouche in Leicestershire, in 1582. He taught a grammar school for some years, and practised physic, employing his leisure hours in astronomy, which was his favourite study: at length he removed to London, was admitted a fellow of the college of physicians, and raised his character by his description of the comet in 1618. The next year Sir Henry Savile appointed him his first professor of astronomy at Oxford; and the masters and fellows of Merton-college made him first junior, and then superior, reader of Linacre's lecture. He died in 1643, having written many works, some of which have never been published: but the MSS. are preserved in the library of Trinity-college, Dublin.

BAIOCAO, a copper-coin, current at Rome, and throughout the whole ſtate of the church, ten of which make a julio, and a hundred a Roman crown.

BAIRAM, or Beiram, a Turkiſh word which ſignifies a ſolemn feaſt. The Mahometans have two Bairams, the *Great* and the *Little*. The *Little* Bairam is properly that held at the cloſe of the faſt Ramazan, beginning with the firſt full moon in the following month Shawal. This is called in Arabic *Id al Fetz*, or *the Feaſt of breaking the Faſt*; by European writers, *the Turkiſh Eaſter*, becauſe it ſucceeds Ramazan, which is their Lent, more uſually the *Great Bairam*, becauſe obſerved with great ceremony and rejoicing at Conſtantinople, and through Turkey, for three days, and in Perſia for five or ſix days, at leaſt by the common people, to make themſelves amends for the mortification of the preceding month. The feaſt commencing with the new moon, the Mahometans are very ſcrupulous in obſerving the time when the new moon commences; to which purpoſe, obſervers are ſent to the tops of the higheſt mountains, who the moment they ſpy the appearance of a new moon, run to the city, and proclaim *Muzhdaluk*, "welcome news;" as it is the ſignal for beginning the feſtivity.—The *Great Bairam*, is properly that held by the pilgrims at Mecca, commencing on the tenth of Dhu Ihajia, when the victims are ſlain, and laſting three days. This is called by the Arabs, *Idal adha*, that is, *the feaſt of ſacrifice*, as being celebrated in memory of the ſacrifice of Abram, whoſe ſon God redeemed with a great victim. By European writers it is called the *Leſſer Bairam*, as being leſs taken notice of by the generality of the people who are not ſtruck with it, becauſe the ceremonies it is obſerved withal, are performed at Mecca, the only ſcene of the ſolemnity.—On the feaſt of Bairam, after throwing little ſtones, one after another, into the valley of Mina, they uſually kill one or more ſheep, ſome a goat, bullock, or even a camel; and after giving a part thereof to the poor, eat the reſt with their friends. After this, they ſhave themſelves. The ſecond is a day of reſt. On the third, they ſet out on their return home.

BAIRUT. See Beeroot.

BAIT, among fiſhermen, implies a ſubſtance proper to be faſtened to a hook, in order to catch the different ſorts of fiſh. See Fishing.

BAITING, the act of ſmaller or weaker beaſts attacking and haraſſing greater and ſtronger. In this ſenſe we hear of the baiting of bulls or bears by maſtiffs or bull-dogs with ſhort noſes, that they may take the better hold.

Utility is pled in juſtification of *bull-baiting*. This animal is rarely killed without being firſt baited; the chafing and exerciſe whereof makes his fleſh tenderer and more digeſtible. In reality, it diſpoſes it for putrefaction; ſo that, unleſs taken in time, baited fleſh is ſoon loſt. But a ſpirit of barbariſm had the greateſt ſhare in ſupporting the ſport: bulls are kept on purpoſe, and exhibited as ſtanding ſpectacles for the public entertainment. The poor beaſts have not fair play: they are not only tied down to a ſtake, with a collar about their necks and a ſhort rope, which gives them not above four or five yards play; but they are diſarmed too, and the tips of their horns cut off, or covered with leather, to prevent their hurting the dogs. In this ſport, the chief aim of the dog is to catch the bull by the noſe, and hold him down; to which end he will even creep on his belly: the bull's aim, on the contrary, is, with equal induſtry, to defend his noſe; in order to which, he thruſts it cloſe to the ground, where his horns are alſo in readineſs to toſs the dog.—Bull-baiting was firſt introduced into England as an amuſement in the reign of King John, about 1209.

BAJULUS, an ancient officer in the court of the Greek emperors. There were ſeveral degrees of bajuli; as, the grand *bajulus*, who was preceptor to the emperor; and the ſimple *bajuli*, who were ſub-preceptors. The word is derived from the Latin verb *bajulare*, "to carry or bear a thing on the arms or on the ſhoulders;" and the origin of the office is thus traced by antiquaries. Children, and eſpecially thoſe of condition, had anciently, beſide their nurſe, a woman called *gerula*, as appears from ſeveral paſſages of Tertullian; when weaned, or ready to be weaned, they had men to carry them about and take care of them, who were called *geruli* and *bajuli*, *a gerendo et bajulando*. Hence it is, that governors of princes and great lords were ſtill denominated *bajuli*, and their charge or government *bajulatio*, even after their pupils were grown too big to be carried about. The word paſſed in the ſame ſenſe into Greece.

Bajulus is alſo uſed by Latin writers in the ſeveral other ſenſes wherein Bailiff is uſed among us.

Bajulus was alſo the name of a conventual officer in the ancient monaſteries, to whom belonged the charge of gathering and diſtributing the money and legacies left for maſſes and obits; whence he was alſo denominated *bajulus obituum novorum*.

BAKAN, a large and handſome town of Aſia in the Eaſt Indies, in the kingdom of Ava. E. Long. 98. 0. N. Lat. 19. 33.

BAKER, Sir Richard, author of the Chronicle of the Kings of England, was born at Seſſingherſt, in Kent, about the year 1568. After going through the uſual courſe of academical learning at Hart-hall, in Oxford, he travelled into foreign parts; and upon his return home was created maſter of arts, and ſoon after, in 1603, received from King James I. the honour of knighthood. In 1620, he was high ſheriff of Oxfordſhire; but engaging to pay ſome of the debts of his wife's family, he was reduced to poverty, and obliged to betake himſelf for ſhelter to the Fleet priſon, where he compoſed ſeveral books; among which are, 1. Meditations and Diſquiſitions on the Lord's Prayer. 2. Meditations, &c. on ſeveral of the Pſalms of David. 3. Meditations and Prayers upon the ſeven Days of the Week. 4. *Cato Variegatus*, or Cato's Moral Diſtichs varied, &c.—Mr Granger obſerves, that his Chronicle of the Kings of England was ever more eſteemed by readers of a lower claſs than by ſuch as had a critical knowledge of hiſtory. The language of it was, in this reign, called polite; and it long maintained its reputation, eſpecially among country gentlemen. The author ſeems to have been ſometimes more ſtudious to pleaſe than to inform, and with that view to have ſacrificed even chronology itſelf to method. In 1658, Edward Philips, nephew to Milton, publiſhed a third edition of this work, with the addition of the reign of Charles I. It has been ſeveral times reprinted ſince, and is now carried as low as the reign of George I.

Baker.

Sir Richard also translated several works from the French and Italian; and died very poor in the Fleet prison, on the 18th of February 1645.

Baker, *Thomas*, an eminent mathematician, was born at Ilton in Somersetshire about the year 1625, and entered at Magdalen hall, Oxon, in 1640; after which he was vicar of Bishop's-Nymmet, in Devonshire, where he wrote The Geometrical Key, or the Gate of Equations unlocked; by which he gained a considerable reputation. A little before his death, the members of the Royal Society sent him some mathematical queries, to which he returned so satisfactory an answer, that they presented him a medal with an inscription full of honour and respect. He died at Bishop's Nymmet on the 5th of June 1690.

Baker, *Thomas*, a very ingenious and learned antiquary, descended from a family ancient and well esteemed, distinguished by its loyalty and affection for the crown, was born at Crook in 1656. He was educated at the free school at Durham, and thence removed to St John's college Cambridge in 1674. He proceeded B. A. 1677; M. A. 1681; was elected fellow, March 1679-80; ordained deacon by Bishop Compton of London, December 20. 1685; priest by Bishop Barlow of Lincoln, December 19. 1686. Dr Watson, tutor of the college, who was nominated, but not yet consecrated, bishop of St David's, offered to take him for his chaplain, which he declined, probably on the prospect of a like offer from Lord Crew bishop of Durham, which he soon after accepted. His lordship collated him to the rectory of Long-Newton in his diocese, and the same county, June 1687; and, as Dr Grey was informed by some of the bishop's family, intended to have given him that of Sedgefield, worth 600l. or 700l. a-year, with a golden prebend, had he not incurred his displeasure and left his family for refusing to read King James II.'s declaration for liberty of conscience. The bishop, who disgraced him for this refusal, and was excepted out of King William's pardon, took the oaths to that king, and kept his bishopric till his death. Mr Baker resigned Long-Newton August 1. 1690, refusing to take the oaths; and retired to his fellowship at St John's, in which he was protected till January 20. 1716-17, when, with one-and-twenty others, he was dispossessed of it. After the passing the Registering Act 1723, he was desired to register his annuity of 40l. which the last act required before it was amended and explained. Though this annuity, left him by his father for his fortune, with 20l. per annum out of his collieries by his elder brother from the day of his death August 1699, for the remaining part of the lease, which determined at Whitsuntide 1722, was now his whole subsistence, he could not be prevailed on to secure himself against the act. He retained a lively resentment of his deprivations; and wrote himself in all his books, as well as in those which he gave to the college library, *socius ejectus*, and in some *ejectus rector*. He continued to reside in the college as commoner-master till his death, which happened July 2. 1740, of a paralytic stroke, being found on the floor of his chamber. In the afternoon of June 29, being alone in his chamber, he was struck with a slight apoplectic fit; which abating a little, he recovered his senses, and knew all about him, who were his nephew Burton, Drs Bedford and Heberden. He seemed perfectly satisfied and resigned; and when Dr Bedford desired him to take some medicine then ordered, he declined it, saying, he would only take his usual sustenance, which his bed-maker knew the times and quantities of giving: he was thankful for the affection and care his friends showed him; but, hoping the time of his dissolution was at hand, would by no means endeavour to retard it. His disorder increased, and the third day from this seizure he departed. Being appointed one of the executors of his elder brother's will, by which a large sum was bequeathed to pious uses, he prevailed on the other two executors, who were his other brother Francis and the Hon. Charles Montague, to lay out 1310l. of the money upon an estate to be settled upon St John's college for six exhibitioners. He likewise gave the college 100l. for the consideration of 6l. a year (then only legal interest) for his life; and to the library several choice books, both printed and MS. medals, and coins; besides what he left to it by his will); which were "all such books, printed and MS. as he had, and were wanting there." All that Mr Baker printed was, 1. "Reflections on Learning, showing the insufficiency thereof in its several particulars, in order to evince the usefulness and necessity of Revelation, Lond. 1709-10" (which went through eight editions: and Mr Boswel, in his "Method of Study," ranks it among the English classics for purity of style); and, 2. "The preface to Bishop Fisher's Funeral Sermon for Margaret Countess of Richmond and Derby, 1708; both without his name. Dr Grey had the original MS of both in his own hands. The latter piece is a sufficient specimen of the editor's skill in antiquities to make us regret that he did not live to publish his "History of St John's College from the foundation of old St John's house to the present time; with some occasional and incidental account of the affairs of the university, and of such private colleges as held communication or intercourse with the old house or college: collected principally from MSS. and carried on through a succession of masters to the end of Bishop Gunning's mastership, 1670." The original, fit for the press, is among the Harleian MSS. N° 7028. His MS. collections relative to the history and antiquities of the university of Cambridge, amounting to 49 volumes in folio and three in quarto, are divided between the British Museum and the public library at Cambridge; the former possesses 23 volumes, which he bequeathed to the earl of Oxford, his friend and patron; the latter 16 in folio and three in quarto, which he bequeathed to the university. Dr Knight styles him "the greatest master of the antiquities of this our university;" and Hearne says, *Optandum est ut sua quoque collectanea de antiquitatibus Cantabrigiensibus juris faciat publici Cl. Bakerus, quippe qui eruditione summa judicioque acri et subacto polleat.* Mr Baker intended something like an *Athenæ Cantabrigienses*, on the plan of the *Athenæ Oxonienses*.

Baker, *Henry*, an ingenious and diligent naturalist, was born in Fleet-street London, either near the end of the last, or very early in the beginning of the present, century. His father's profession is not known; but his mother was, in her time, a midwife of great practice. He was brought up under an eminent bookseller, who preceded the elder Dodsley, to the business of a bookseller; in which, however, he appears

Baker.

pears not to have engaged at all after his apprenticeship; or, if he did, it was soon relinquished by him: for though it was in his power to have drawn away all his master's best customers, he would not set up against him. Mr Baker being of a philosophical turn of mind, and having diligently attended to the methods which might be practicable and useful in the cure of stammering, and especially in teaching deaf and dumb persons to speak, he made this the employment of his life. In the prosecution of so valuable and difficult an undertaking, he was very successful; and several of his pupils, who are still living, bear testimony to the ability and good effect of his instructions. He married Sophia, youngest daughter of the famous Daniel Defoe, who brought him two sons, both of whom he survived. On the 29th of January 1740 Mr Baker was elected a fellow of the Society of Antiquaries; and, on the 12th of March following, the same honour was conferred upon him by the Royal Society. In 1744, Sir Godfrey Copley's gold medal was bestowed upon him, for having, by his microscopical experiments on the crystallizations and configuration of saline particles, produced the most extraordinary discovery during that year. Having led a very useful and honourable life, he died at his apartments in the Strand on the 25th of November 1774, being then above 70 years of age. His wife had been dead some time before; and he only left one grandson, William Baker, who was born February 17. 1763, and to whom, on his living to the age of 21, he bequeathed the bulk of his fortune, which he had acquired by his profession of teaching deaf and dumb persons to speak. His furniture, printed books (but not MSS.), curiosities, and collections of every sort, he directed should be sold, which was accordingly done. His fine collection of native and foreign fossils, petrifactions, shells, corals, vegetables, ores, &c. with some antiquities and other curiosities, were sold by auction March 13. 1775, and the nine following days. He was buried, as he desired, in an unexpensive manner, in the churchyard of St Mary-le-strand; within which church, on the south wall, he ordered a small tablet to be erected to his memory. "An inscription for it (he said) would probably be found among his papers; if not, he hoped some learned friend would write one agreeable to truth." This friendly office, however, remains as yet to be performed. Mr Baker was a constant and useful attendant at the meetings of the Royal and Antiquarian Societies, and in both was frequently chosen one of the council. He was peculiarly attentive to all the new improvements which were made in natural science, and very solicitous for the prosecution of them. Several of his communications are printed in the Philosophical Transactions; and, besides the papers written by himself, he was the means, by his extensive correspondence, of conveying to the society the intelligence and observations of other inquisitive and philosophical men, both at home and abroad. The Society for the encouragement of arts, manufactures, and commerce, is under singular obligations to our worthy naturalist. As he was one of the earliest members of it, so he contributed in no small degree to its rise and establishment. At its first institution he officiated for some time *gratis* as secretary. He was many years chairman of the committee of accounts; and he took an active part in the general deliberations of the society. He drew up a short account of the original of this society, and of the concern he himself had in forming it; which was read before the society of antiquaries, and would be a pleasing present to the public. Mr Baker was a poetical writer in the early part of his life. His *Invocation of Health* got abroad without his knowledge; but was reprinted by himself in his *Original Poems, serious and humorous*, Part I. 8vo. 1725. Part II. came out in 1726. Among these poems are some tales as witty and as loose as Prior's. He was the author likewise of *The Universe*, a poem intended to restrain the pride of man; which has been several times reprinted. His account of the water polype, which was originally published in the Philosophical Transactions, was afterwards enlarged into a separate treatise, and hath gone through several editions. But this principal publications are, *The Microscope made Easy*, and *Employment for the Microscope*. The first of these, which was originally published in 1742 or 1743, hath gone through six editions. The second edition of the other, which, to say the least of it, is equally pleasing and instructive, appeared in 1764. These treatises, and especially the latter, contain the most curious and important of the observations and experiments which Mr Baker either laid before the Royal Society or published separately. It has been said of Mr Baker, that *he was a philosopher in little things*. If it was intended by this language to lessen his reputation, there is no propriety in the stricture. He was an intelligent, upright, and benevolent man, much respected by those who knew him best. His friends were the friends of science and virtue: and it will always be remembered by his contemporaries, that no one was more ready than himself to assist those with whom he was conversant in their various researches, and endeavours for the advancement of knowledge and the benefit of society.

Baker, *David-Erskine*, son to the former, was a young man of genius and learning. Having been adopted by an uncle, who was a silk-throwster in Spitalfields, he succeeded him in the business; but wanted the prudence and attention which are necessary to secure prosperity in trade. He married the daughter of Mr Clendon, a reverend empiric. Like his father, he was both a philosopher and a poet; and wrote several occasional poems in the periodical collections, some of which were much admired at the time; but so violent was his turn for dramatic performance, that he repeatedly engaged with the lowest strolling companies, in spite of every effort of his father to reclaim him. The public was indebted to him for "The Companion to the Play-house," in two volumes, 1764, 12mo; a work which, though imperfect, had considerable merit, and showed that he possessed a very extensive knowledge of our dramatic authors; and which has since (under the title of "Biographia Dramatica") been considerably improved by the attention of a gentleman in every respect well qualified for the undertaking.

Baker, a person whose occupation or business is to bake bread. See the articles Baking and Bread.

The learned are in great doubt about the time when baking first became a particular profession and bakers were introduced. It is however generally agreed, that they had their rise in the east, and passed from Greece to to Italy after the war with Pyrrhus, about the year of Rome 583. Till which time every houſewiſe was her own baker; for the word *piſtor*, which we find in Roman authors before that time, ſignified a perſon who ground or pounded the grain in a mill or mortar to prepare it for baking, as Varro obſerves. According to Athenæus, the Cappadocians were the moſt applauded bakers, after them the Lydians, then the Phœnicians.—To the foreign bakers brought into Rome, were added a number of freed men, who were incorporated into a body, or, as they called it, a *college;* from which neither they nor their children were allowed to withdraw. They held their effects in common, and could not diſpoſe of any part of them. Each bake-houſe had a patronus, who had the ſuperintendency thereof; and theſe patroni elected one out of their number each year, who had ſuperintendence over all the reſt, and the care of the college. Out of the body of the bakers every now and then one was admitted among the ſenators.—To preſerve honour and honeſty in the college of bakers, they were expreſsly prohibited all alliance with comedians and gladiators; each had his ſhop or bake-houſe, and they were diſtributed into fourteen regions of the city. They were excuſed from guardianſhips and other offices, which might divert them from their employment.—By our own ſtatutes bakers are declared not to be handicrafts. No man for uſing the myſteries or ſciences of baking, brewing, ſurgery, or writing, ſhall be interpreted a handicraft. The bakers were a brotherhood in England before the year 1155, in the reign of King Henry II. though the white bakers were not incorporated till 1407, by King Edward III. and the brown bakers not till 1621, in King James I.'s time. Their hall is in Harp-lane, Thames-ſtreet; and their court-day on the firſt Monday of the month.—They make the 19th company; and conſiſt of a warden, 4 maſters, 30 aſſiſtants, and 140 men on the livery, beſides the commonalty.—The French had formerly a great baker, *grand. panetier de France*, who had the ſuperintendency of all the bakers of Paris. But ſince the beginning of this century, they have been put under the juriſdiction of the lieutenant-general *de police.* In ſome provinces of France, the lord is the only baker in his ſeigneury; keeping a public oven, to which all the tenants are obliged to bring their bread. This right is called *furnagium*, or *furnaticum*, and makes part of the *bannalite.*

BAKEWELL, a pretty large town of Derbyſhire in England, ſeated on the river Wye, on the north ſide of the Peak. It has a conſiderable trade in lead. W. Long. 2. 30. N. Lat. 55. 15.

BAKING, the art of preparing bread, or reducing meals of any kind, whether ſimple or compound, into bread. See the article BREAD.

The various forms of baking among us may be reduced into two, the one for unleavened, the other for leavened bread. For the firſt, the chief is manchet-baking; and the proceſs whereof is as follows: The meal, ground and boulted, is put into a trough; and to every buſhel are poured in about three pints of warm ale, with barm and ſalt to ſeaſon it. This is kneaded well together with the hands through the brake; or, for want thereof, with the feet, through a cloth; after which, having lain an hour to ſwell, it is moulded into manchets; which, ſcorched in the middle, and pricked up at top, to give room to riſe, are baked in the oven by a gentle fire.—For the ſecond, ſometimes called *cheat-bread baking*, it is thus: Some leaven (ſaved from a former batch) filled with ſalt, laid up to ſour, and at length diſſolved in water, is ſtrained through a cloth into a hole made in the middle of the heap of meal in the trough; then it is worked with ſome of the flour into a moderate conſiſtence: this is covered up with meal, where it lies all night; and in the morning the whole heap is ſtirred up, and mixed with a little warm water, barm, and ſalt, by which it is ſeaſoned, ſoftened, and brought to an even leaven: it is then kneaded, moulded, and baked, as before.

Method of raiſing a buſhel of flour with a tea-ſpoonful of barm; by James Stone, of Amport, in Hampſhire.—Suppoſe you want to bake a buſhel of flour, and have but one tea-ſpoonful of barm. Put your flour into your kneading-trough or trendle; then take about three quarters of a pint of warm water, and take the tea ſpoonful of thick ſteady barm and put it into the water, ſtir it until it is thoroughly mixed with the water: then make a hole in the middle of the flour large enough to contain two gallons of water; pour in your ſmall quantity; then take a ſtick about two feet long, (which you may keep for that purpoſe), and ſtir in ſome of the flour, until it is as thick as you would make batter for a pudding; then ſtrew ſome of the dry flour over it, and go about your uſual buſineſs for about an hour: then take about a quart of warm water more, and pour in; for in one hour you will find that ſmall quantity raiſed ſo, that it will break through the dry flour which you ſhook over it; and when you have poured in the quart of warm water, take your ſtick as before, and ſtir in ſome more flour, until it is as thick as before; then ſhake ſome more dry flour over it, and leave it for two hours more, and then you will find it riſe and break through the dry flour again; then you may add three quarts or a gallon of water more, and ſtir in the flour and make it as thick as at firſt, and cover it with dry flour again; in about three or four hours more you may mix up your dough, and then cover it up warm; and in four or five hours more you may put it into the oven, and you will have as light bread as though you had put a pint of barm. It does not take above a quarter of an hour more time than the uſual way of baking, for there is no time loſt but that of adding water three or four times.

The author of this method aſſures us that he conſtantly bakes this way in the morning about ſix or ſeven o'clock, puts the flour out, and puts this ſmall quantity of barm into the before-mentioned quantity of water, in an hour's time ſome more, in two hours more a greater quantity, about noon makes up the dough, and about ſix in the evening it is put into the oven, and he has always good bread, never heavy nor bitter.

When you find, he ſays, your body of flour ſpunged large enough, before you put in the reſt of your water, you ſhould, with both your hands, mix that which is ſpunged and the dry flour altogether, and then add the remainder of warm water, and your dough will riſe the better and eaſier.

The reaſon he aſſigns why people make heavy bread is, not becauſe they have not barm enough, but becauſe they do not know that barm is the ſame to flour as

Bakou, Balaam.

as fire is to fuel; that, as a ſpark of fire will kindle a large body by only blowing of it up, ſo will a thimble-full of barm, by adding of warm water, raiſe or ſpungé any body of flour; for warm water gives freſh life to that which is before at work; ſo that the reaſon of making bread heavy is, becauſe the body ſpunged is not large enough, but was made up and put into the oven before it was ripe.

In regard to the difference of ſeaſons, he preſcribes, that in the ſummer you ſhould put your water blood-warm; and in winter, in cold froſty weather, as warm as you can bear your hand in it without making it ſmart; being ſure you cover up your dough very warm in the winter, and your covering of it with dry flour every time you add warm water, will keep in the heat; when you have added ſix or eight quarts of warm water, as before-mentioned, in ſuch a gradual way, you will find all the body of flour which is mixed with the warm water, by virtue of that one tea-ſpoonful of barm, brought into great agitation, waxing or fermenting; for it is to the flour what the ſpirit is to the body. It ſoon fills it with motion.

BAKOU, or BAKU, a town of Perſia, in the province of Shirvan, ſituated at the extremity of the gulf of Ghilan on the Caſpian ſea. It is eſteemed the moſt commodious haven in this ſea, as veſſels may there ride ſecurely at anchor in ſeven fathom water; but the number of ſhoals, iſlands, and ſand-banks, render the entrance in ſome places extremely difficult and dangerous, particularly to the Ruſſians, who are not very expert ſailors. Baku is a fortreſs ſurrounded with high brick walls; its inhabitants, like thoſe of Derbent, are Perſians, Tartars, and a few Armenian merchants. The principal articles of exportation which ſupport the trade of this place are naphtha, and the fineſt rock ſalt, of both which there are mines on the eaſt ſide of the bay. The inhabitants cultivate ſaffron and the cotton tree, but not to any conſiderable advantage. The trade of Baku, though more valuable than that of Derbent, is ſtill inconſiderable, and chiefly carried on with Shamakee, from whence it draws raw ſilk and ſilken ſtuffs. A Ruſſian conſul is reſident at this place. In 1777 Baku belonged to Melik-Mehmed, who was tributary to Feth Ali khan of Kuba: the latter poſſeſſed the whole province of Shirvan, and was the moſt powerful prince, next to the khan of Ghilan, upon the coaſt of the Caſpian. Before we quit the province of Shirvan, it may not be improper to mention its capital, the inland town of Shamakee, which is only 66 miles from Baku, and ſupplies that port with raw ſilk and ſilken ſtuffs. It owed its former commercial importance to the ſilk which is cultivated in the neighbouring diſtrict; this rich production ſtill preſerves the town from ruin; though its traffic is greatly reduced by the exorbitant exactions of the khan of Kuba. Formerly the Ruſſians had a factory at this place; and it was alſo crowded with Turkiſh and Greek merchants; but at preſent there are only a few Armenian and Indian traders. The inhabitants manufacture ſilk and cotton ſtuffs, but far inferior to thoſe made at this place in the beginning of the preſent century. The ſilk of this province is exported into the interior part of Perſia, Turkey, Georgia, and Ruſſia. E. Long. 51. 30. N. Lat. 40. 20.

BALAAM, a prophet and diviner of the city of Pethor upon the Euphrates, whoſe practices with Balak king of the Moabites are recorded in the book of Numbers, chap. xxii. It is a queſtion much debated among divines, whether Balaam was a true prophet of God, or no more than a magician or fortune-teller. The Jews indeed are generally of opinion, that he was a buſy and pretending aſtrologer, who, obſerving when men were under a bad aſpect of the ſtars, pronounced a curſe upon them; which ſometimes coming to paſs, gained him in ſome neighbouring nations a reputation in his way. Several of the ancient fathers ſuppoſe him to be no more than a common ſoothſayer, who undertook to tell future events, and diſcover ſecrets, and by no very juſtifiable arts. Origen will needs have it, that he was no prophet, but only one of the devil's ſorcerers, and that of him he went to inquire; but that God was pleaſed to prevent him, and put what anſwers he pleaſed into his mouth. It cannot be denied, however, that the ſcripture expreſsly calls him a prophet (Pet. ii. 5.); and therefore ſome later writers have imagined that he had once been a good man and true prophet, till loving the wages of iniquity, and proſtituting the honour of his office to covetouſneſs, he apoſtatized from God, and betaking himſelf to idolatrous practices, fell under the deluſion of the devil, of whom he learned all his magical enchantments, though at this juncture, when the preſervation of his people was concerned, it might be conſiſtent with God's wiſdom to appear to him, and vouchſafe his revelations. As to what paſſed between him and his aſs, when that animal was miraculouſly enabled to ſpeak to its maſter, commentators are divided in their opinions concerning this fact, whether it really and literally happened as Moſes relates it; or whether it be an allegory only, or the mere imagination or viſion of Balaam. This indeed is ſo wonderful an inſtance, that ſeveral of the Jewiſh doctors, who upon other occaſions are fond enough of miracles, ſeem as if they would hardly be induced to aſſent to this. Philo, in his *Life of Moſes*, paſſes it over in ſilence; and Maimonides pretends that it happened to Balaam in a prophetic viſion only. But St Peter (2 Pet. ii. 16.) ſpeaks of this fact as literal and certain, and ſo all interpreters explain it. St Auſtin, who underſtands it exactly according to the letter, finds nothing in the whole account more ſurpriſing than the ſtupidity of Balaam, who heard his aſs ſpeak to him, and anſwered it as if he talked with a reaſonable perſon. He is of opinion, that this diviner was accuſtomed to prodigies like this, or that he was ſtrangely blinded by his avarice not to be ſtopped by an event of ſo extraordinary a nature. Le Clerc thinks, that Balaam might probably have imbibed the doctrine of tranſmigration of ſouls, which was certainly very common in the eaſt; and from thence he might be the leſs aſtoniſhed at hearing a brute ſpeak. And Dr Patrick thinks that Balaam was in ſuch a rage and fury at the ſuppoſed perverſeneſs of his beaſt cruſhing his foot, that for the preſent he could think of nothing elſe; though the conciſeneſs of Moſes's relation, who muſt be preſumed to have omitted many circumſtances, which if rightly known would diſpel this and many more difficulties that may be imagined in this tranſaction, does certainly furniſh us with a better and more ſatisfactory anſwer. St Auſtin is of opinion, that God had not given the aſs a reaſonable ſoul; but permitted it to pro-

nounce

nounce certain words, in order to reprove the prophet's covetousness. Gregory of Nyssa seems to think that the ass did not utter any word articulately or distinctly; but that, having brayed as usual, the diviner, whose practice it had been to draw presages from the cries of beasts and singing of birds, comprehended easily the ass's meaning by its noise; Moses, designing to ridicule this superstitious art of augurs and soothsayers, as if the ass really spoke in words articulate.

We must own, says Calmet, that this is a miraculous fact related by an inspired writer, whose authority we are not allowed to call in question in the least particular: but we should study such ways of explaining it as are most conformable to reason, and most proper to solve the difficulties of it, without attacking the truth of the history. Now it is very possible for God to make an ass speak articulately; it is indeed miraculous, and above the ordinary faculty of this animal, but not against the laws of nature.

BALADAN, the scripture name for a king of Babylon (Isa. xxxix. 1. 2 Kings xx. 12.), called by profane authors *Belesus* or *Belesis*, *Nabonassar* or *Nanybrus*. Baladan at first was no more than governor of Babylon; but entering into a confederacy with Arbaces governor of Media, and rebelling against Sardanapalus king of Assyria, these two generals marched against him with an army of 400,000 men, and were beat in three different battles. But the Bactrians deserting the king, and coming over to Baladan and Arbaces, the rebels attacked the enemy in the night, and made themselves masters of his camp. After this misfortune, Sardanapalus retreated to Nineveh, and left the command of his army to his brother-in-law Salamenes. The conspirators attacked Salamenes, and defeated him in two great battles; after which they laid siege to Nineveh. Sardanapalus sustained the siege for three years; but the Tigris, in the third year, overflowing its banks, beat down 20 furlongs of the walls; whereupon the conspirators entered the city and took possession of it, after Sardanapalus had burnt himself and all his most valuable effects upon a funeral pile erected for that purpose in his palace. Baladan was acknowledged king of Babylon as Arbaces was of Media. Berodach-baladan, who sent ambassadors to Hezekiah (2 Kings xx.), was the son of Baladan.

BALA, a town of Merionethshire in Wales. W. Long. 3. 37. N. Lat. 52. 54.

BALÆNA, or WHALE. See CETOLOGY *Index*.

BALAGATE, a province of the Mogul empire, and the largest of the three that compose the kingdom of Dekkan. It has Kandish and Barar to the north, Tellinga to the east, Baglana with part of Guzerat to the west, and Visiapour to the south. It is a fruitful and pleasant country, abounding with cotton and sugar. Here they have sheep without horns; but so strong, that when bridled and saddled they will carry boys of ten years of age. Its present capital is Aurengabad, but formerly was Dowlet Abad; and from the latter the whole province is sometimes called *Dowlet-Abad*.

BALAGATE *Mountains*, a chain of mountains which divides the coast of Malabar from that of Coromandel, running almost the whole length of the peninsula on this side the Ganges. Some parts of them are covered with fine red earth, which is blown by the strong west

winds as far as the island of Ceylon; and when the rays of the sun are reflected from these mountains, they seem to be all on fire. They make surprising alterations in the seasons; for on the north side of Cape Comorin, it is winter in May, June, July, August, and September, in which months it is summer on the south side of the cape; on one side there are continual tempests, thunder and lightning, while the other enjoys a constant serenity. When black clouds are gathered about the mountains, they are followed by sudden rain, which causes the overflowing of the rivers, and choaks them up with sand, insomuch that they are unnavigable for some time afterwards. The buildings and clothes of the inhabitants are scarce sufficient to defend them from the weather. They live upon rice, milk, roots, and herbs, with very little meat; they have likewise a sort of small arrack, but are never given to drunkenness; nor do they import foreign vices, for they never travel abroad.

BALAGNIA, a town of Muscovy in the province of Little Novogorod, seated on the Wolga. E. Long. 45. 5. N. Lat. 50. 36.

BALAGUER, a city of Catalonia in Spain, seated on the north bank of the river Segra, at the foot of a high mountain, on which there was formerly a fortress. E. Long. 0. 48. N. Lat. 41. 38.

BALAMBUAN, or PADAMBUAN, a strong town of Asia, in the Indies, on the east end of the island of Java, and capital of a territory of the same name. E. Long. 115. 30. S. Lat. 7. 50.

BALANCE, or BALANCE, one of the six simple powers in mechanics, principally used in determining the equality or difference of weights in heavy bodies, and consequently their masses or quantities of matter.

The balance is of two kinds: the ancient and the modern. The ancient or Roman, called also the *statera Romana*, or steel-yard, consists of a lever or beam, moveable on a centre, and suspended near one of its extremities: the bodies to be weighed are applied on one side of the centre; and their weight is shown by the division marked on the beam, where the weight, which is moveable along the lever, keeps the steel-yard *in equilibrio*. This balance is still frequently used in weighing heavy bodies.

The modern balance now generally used consists of a lever or beam suspended exactly in the middle, having scales or basons hung to each extremity. The lever is called the *jugum* or *beam*; and the two moieties thereof on each side the axis, the *brachia* or *arms*. The line on which the beam turns, or which divides its brachia, is called the *axis*; and when considered with regard to the length of the brachia, is esteemed a point only, and called the *centre of the balance*; the handle whereby it is held, or by which the whole apparatus is suspended, is called *trutina*; and the slender part perpendicular to the beam, whereby either the equilibrium or preponderancy of bodies is indicated, is called the *tongue* of the balance. Thus in fig. 1. Pl. 84. *ab* is the beam, divided into two equal brachia or arms by the white spot in the centre, which is the axis or centre of the balance, and *c* is the tongue. The trutina, on which the axis is suspended, is not represented in this figure, in order to render the other parts more conspicuous.

It follows, from what has been observed, therefore, that

Plate LXXXIV.

BALANCE.

Fig. 6. Balista.

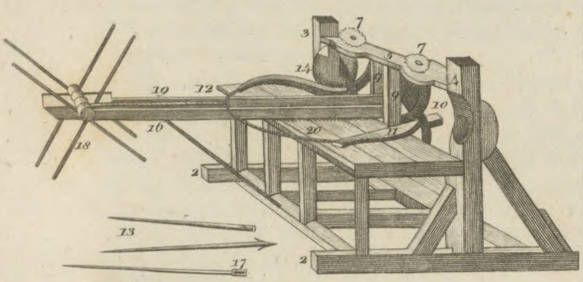


Fig. 3. Common Balance.

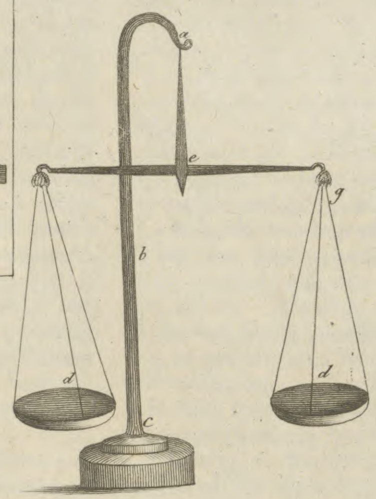


Fig. 1.

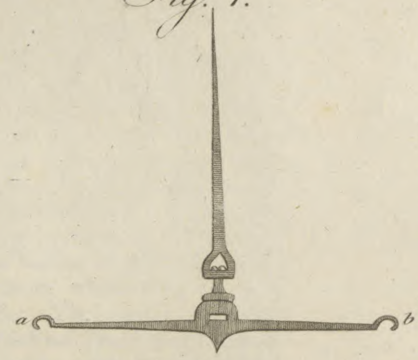


Fig. 5. Hydrostatic Balance.

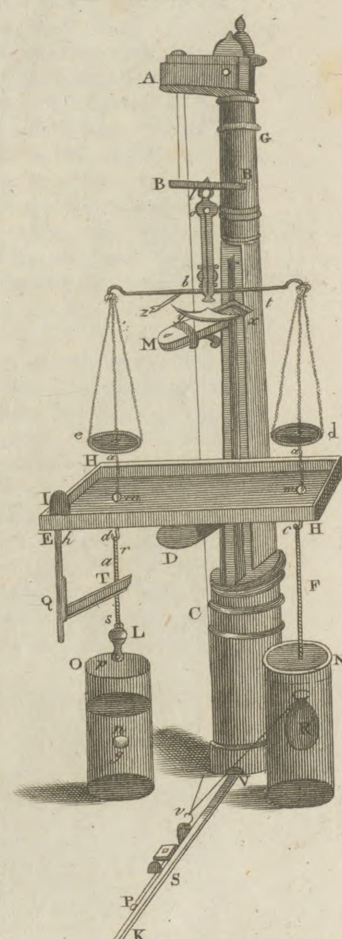


Fig. 2. Roman Balance.

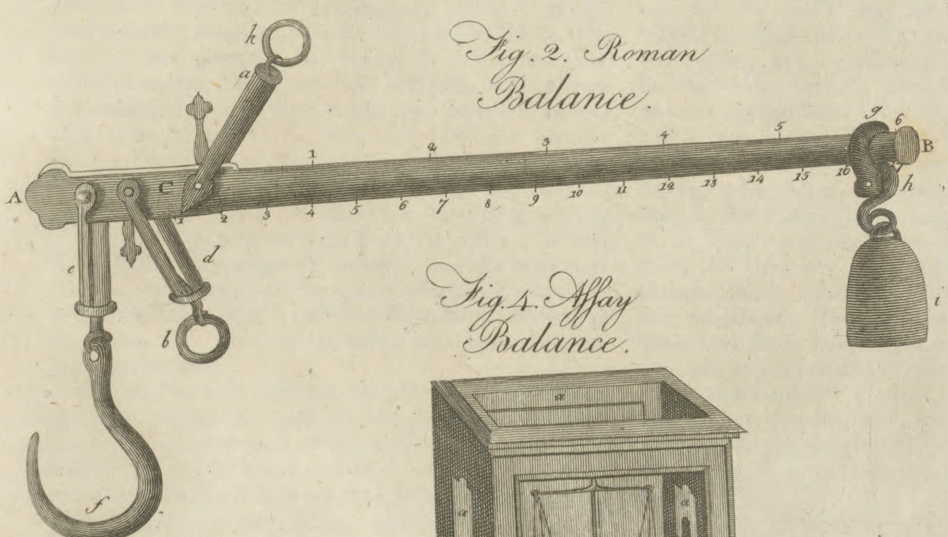
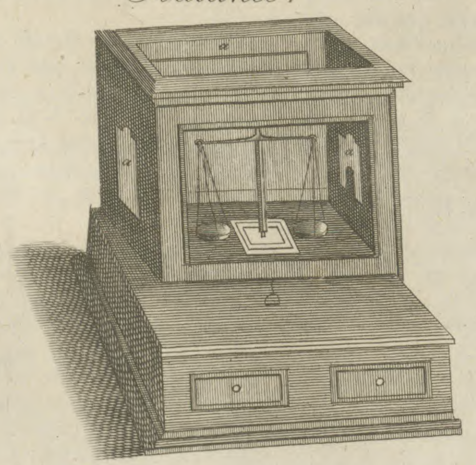


Fig. 4. Assay Balance.



A Bell Prin. Wal. Sculptor fecit.

that in the Roman balance, the weight uſed for a counterpoiſe is the ſame, but the point of application varies; in the common balance the counterpoiſe is various, and the point of application the ſame. The principle on which each is founded, may be very eaſily underſtood from the following obſervations, and the general properties of the lever. See LEVER.

The beam A B (fig. 2.), is a lever of the firſt kind; but inſtead of reſting on a fulcrum, is ſuſpended by ſomething faſtened to its centre of motion: conſequently the mechaniſm of the balance depends on the ſame theorems as the lever.

Hence as the quantity of matter in a known weight is to its diſtance from the centre of motion, ſo is the diſtance of the unknown weight to its quantity of matter. Hence the nature and uſe of the ſteel-yard is eaſily known. Let AB (fig. 2.) repreſent an inſtrument of this kind; *a*, the trutina, or handle on which the beam turns; *k*, a ring on which the balance may be ſuſpended on a nail or hook; *f*, the hook on which the body to be weighed is hung; *c*, a collar or guard by which the hook *f* is faſtened to the beam; *g*, a moveable collar; *h*, a ſwivel; *i*, the counterpoiſe. From what has been ſaid it evidently follows, that if the body to be weighed be faſtened to the hook *f*, and the whole ſuſpended by the ring *k*, the diviſion on which the counterpoiſe is placed to maintain an equilibrium in the balance, will ſhow the weight of the body required; provided the weight of the counterpoiſe *i* be known, and the large diviſions, 1, 2, 3, &c. be equal to the diſtance between the centre of the balance and the ſcrew which faſtens the guard *c* to the ſhorter arm of the balance. It will alſo be neceſſary that the ſteel-yard itſelf, with its whole apparatus, excluſive of the counterpoiſe, be *in equilibrio*, when ſuſpended on the ring *k*. If the body to be weighed be heavier than the diviſions on the longer arm will indicate, the balance is turned the lower ſide upwards, and ſuſpended on the other ring *b*; by which means the diviſions become ſhorter, becauſe the diſtance between the trutina *d*, and the ſcrew on which the guard *c* moves, is leſs: the diviſions in the figure on this ſide extending to 17, whereas they extend only to 6 on the other. It will be unneceſſary perhaps to obſerve, that the ſame precaution, with regard to the centre of gravity when the balance is ſuſpended, is alſo neceſſary when this ſide of the balance is uſed, as we before mentioned with regard to the other.

We have already obſerved, that in the common ſcales the two brachia or arms of the balance, *e f*, *e g*, fig. 3. are equal to each other, and conſequently equal weights placed in the ſcales *d*, *d*, will be *in equilibrio* when the balance is ſuſpended on its centre *e*, as in the figure, where the ring at the extremity of the trutina is hung on the tapering rod *a b*, fixed in the foot or baſis *c*.

The Deceitful BALANCE, or that which cheats by the inequality of its brachia, is founded on the ſame principle as the ſteel-yard. Let there be, for example, a balance ſo conſtructed, that both the brachia with their ſcales ſhall equiponderate, but that the length of the one arm ſhall be to that of the other as 10 to 9. In this caſe, a weight of nine pounds put into the longeſt arm, will counterpoiſe one of ten pounds put into the ſhorter one: but the cheat is immediately diſcovered by ſhifting the weight from one ſcale to the other; in which caſe, the balance will no longer remain *in equilibrio*.

Aſſay-BALANCE, a very nice balance uſed in docimaſtical operations, to determine exactly the weight of minute bodies; ſee fig. 4. This balance ſhould be made of the beſt ſteel, and of the hardeſt kind; becauſe that metal is not ſo eaſily ſpoiled with ruſt as iron; and it is more apt than any other to take a perfect poliſh, which at the ſame time prevents the ruſt.

The ſtructure of the aſſayer's ſcale is little different from that of common ſcales, otherwiſe than by its nicety and ſmallneſs. The longer the beam of it is, the more exact may the weight of a body be found; however, 10 or 12 inches are ſufficient length. Let the thickneſs of it be ſo little, that two drachms may hardly be hung at either of its extremities without its bending; for the largeſt weight put upon it ſeldom exceeds one dram. The whole ſurface of this beam muſt be altogether without ornaments, which only increaſe the weight and gather duſt, &c. The beam is ſuſpended in a fork, the two legs of which are ſteel ſprings joined at top, but kept together below with a braſs pliant claſp, parallel, and two lines and a half diſtant from each other. This claſp being taken off, and the legs of the fork being ſtretched out, the axis of the beam may be put into two holes made for that purpoſe at the ends of the legs, or be taken away from them. Let a very ſharp needle be fixed in the head of the fork, ſtanding perpendicularly downwards, if the fork is ſuſpended, and ſo long, as that it may almoſt touch the top of the tongue of the beam put into the fork when in equilibrio. This needle is the mark of the equilibrium; and that the artiſts may be able to obſerve this, the legs of the fork muſt be broader in that place, and have an opening two or three lines wide; this fork may be adorned at pleaſure, provided the motion of the balance is not hindered by ſuch ornaments: then take two ſcales made of thin plate of ſilver, one inch and a half in diameter, hanging on three ſmall ſilk ſtrings, almoſt as long as the beam, tied together at top, with a ſilver hook in form of an S, and hang them to the extremities of the beam: a ſmaller ſilver diſh or blued ſteel, ſomewhat leſs than one inch in diameter, belongs to each of theſe ſcales. You firſt put into theſe diſhes, with a pair of pincers, the bodies to be weighed, or with a ſpoon or a ſmall ſhovel, when they are pounded, and then you put them into the ſcales; therefore the ſmall diſhes muſt be perfectly equal in weight. We uſe them, that bodies may be more conveniently put into and taken out of the ſcales, and that theſe which are vaſtly thin may not be bent or ſoiled, and thence rendered falſe by wiping.

This balance is ſuſpended on a moveable braſs or copper ſupport, which conſiſts of a pedeſtal, and of a column ſet upon it about 20 inches high, at the top of which comes out at right angles an arm one inch long. At the extremity of this arm, put a ſmall pulley three lines in diameter, another at the top of the column, and a third near the bottom of it; all which pulleys muſt turn very eaſily on their axes. At the diſtance of one inch and a half below the upper arm, let another arm one inch and a half long come out of the column at right angles, having a hole through it two lines long, a quarter of a line broad, and placed perpendicularly

Balance. pendicularly below the pulley of the upper arm, to receive a ſmall plate, one inch and a half long; and of ſuch breadth and thickneſs, as that it may freely move up and down, and yet not have too much play within the hole. This plate muſt alſo have a ſmall hook at each extremity.

And as ſuch a balance will hardly ſtand ſtill in the open air, and becomes falſe when ſpoiled with duſt, it muſt be put, together with its ſupport, into a ſmall caſe as repreſented in fig. 4. having glaſſes, *a*, *a*, *a*, at top, and all round it, that you may ſee what is within.

*Manner of uſing the Aſſay-*Balance.—Paſs a ſilk ſtring over the three pulleys of the ſupport, and tie it at its upper extremity to the ſmall hook introduced into the hole of the inferior arm; then put the ſupport in the middle of the ſmall caſe, and paſs the other extremity of the ſilk ſtring below, through a hole bored in the middle of the lower part of the frame, containing the window in the fore-part of the caſe, and faſten it to a ſmall weight of a cubic form. Suſpend the fork of the balance on the inferior hook of the plate. By this means if you move backwards and forwards the weight faſtened to the ſtring, placed upon the top of the drawer jutting out beyond the fore-part of the caſe, the balance within is either lifted up or let down. But you muſt put the bodies to be weighed, and the weights themſelves, into the ſmall ſilver diſhes; and theſe, when loaded, into the ſcales, through the ſide-windows, which muſt be opened for that purpoſe. When any thing is to be added to or taken out of them, you do it with the ſmall pincers; or, if it is powder, with the ſmall ſhovel or ſpoon: but you muſt let the balance down every time any thing is to be added or taken away, that the ſcales may reſt upon the bottom of the caſe; and ſhut the windows before the balance is lifted up again, eſpecially if the air is not perfectly calm.

Hydroſtatic Balance, an inſtrument contrived to determine accurately the ſpecific gravity of both ſolid and fluid bodies. It is conſtructed in various forms; but we ſhall content ourſelves here with deſcribing that which appears of all others the moſt accurate.

VCG (fig. 5.) is the ſtand or pillar of this hydroſtatic balance, which is to be fixed in a table. From the top A hangs, by two ſilk ſtrings, the horizontal bar BB, from which it is ſuſpended by a ring *i*, the fine beam of a balance *b*; which is prevented from deſcending too low on either ſide by the gently ſpringing piece *t x y z*, fixed on the ſupport M. The harneſs is annulated at *o*, to ſhow diſtinctly the perpendicular poſition of the examen, by the ſmall pointed index fixed above it.

The ſtrings by which the balance is ſuſpended, paſſing over two pulleys, one on each ſide the piece at A, go down to the bottom on the other ſide, and are hung over the hook at *v*; which hook, by means of a ſcrew P, is moveable about one inch and a quarter, backward and forward, and therefore the balance may be raiſed or depreſſed ſo much. But if a greater elevation or depreſſion be required, the ſliding piece S, which carries the ſcrew P, is readily moved to any part of the ſquare braſs rod VK, and fixed by means of a ſcrew.

The motion of the balance being thus adjuſted, the reſt of the apparatus is as follows. HH is a ſmall board, fixed upon the piece D, under the ſcales d and e, and is moveable up and down in a low ſlit in the pillar above C, and faſtened at any part by a ſcrew behind. From the point in the middle of the bottom of each ſcale hangs, by a fine hook, a braſs wire *a d* and *a c*. Theſe paſs through two holes *m m* in the table. To the wire *a d* is ſuſpended a curious cylindric wire *r s*, perforated at each end for that purpoſe: this wire *r s* is covered with paper, graduated by equal diviſions, and is about five inches long.

In the corner of the board at E, is fixed a braſs tube, on which a round wire *h l* is ſo adapted as to move neither too tight nor too free, by its flat head I. Upon the lower part of this moves another tube Q, which has ſufficient friction to make it remain in any poſition required: to this is fixed an index T, moving horizontally when the wire *h l* is turned about, and therefore may be eaſily ſet to the graduated wire *r s*. To the lower end of the wire *r s* hangs a weight L; and to that a wire *p n*, with a ſmall braſs ball *g* about one-fourth of an inch diameter. On the other ſide, to the wire *a c*, hangs a large glaſs bubble R, by a horſe-hair.

Let us firſt ſuppoſe the weight L taken away, and the wire *p n* ſuſpended from S: and, on the other ſide, let the bubble R be taken away, and the weight F, ſuſpended at *c*, in its room. This weight F we ſuppoſe to be ſufficient to keep the ſeveral parts hanging to the other ſcale in equilibrium; at the ſame time that the middle point of the wire *p n* is at the ſurface of the water in the veſſel N. The wire *p n* is to be of ſuch a ſize, that the length of one inch ſhall weigh four grains.

Now it is evident, ſince braſs is eight times heavier than water, that for every inch the wire ſinks in the water it will become half a grain lighter, and half a grain heavier for every inch it riſes out of the water: conſequently, by ſinking two inches below the middle point, or riſing two inches above it, the wire will become one grain lighter or heavier. Therefore, if, when the middle point is at the ſurface of the water in equilibrium, the index T be ſet to the middle point *a* of the graduated wire *r s*, and the diſtance on each ſide *a r* and *a s* contains 100 equal parts: then, if in weighing bodies the weight is required to the hundredth part of a grain, it may be eaſily had by proceeding in the following manner.

Let the body to be weighed be placed in the ſcale d. Put the weight X in the ſcale e; and let this be ſo determined, that one grain more ſhall be too much, and one grain leſs too little. Then the balance being moved gently up or down, by the ſcrew P, till the equilibrium be nicely ſhown at *o*; if the index T be at the middle point *a* of the wire *r s*, it ſhows that the weights put into the ſcale e are juſt equal to the weight of the body. By this method we find the abſolute weight of the body; the relative weight is found by weighing it hydroſtatically in water, as follows.

Inſtead of putting the body into the ſcale e, as before, let it hang with the weight F, at the hook *c*, by a horſe-hair, as at R, ſuppoſing the veſſel O of water were away. The equilibrium being then made, the index T ſtanding between *a* and *r*, at the 36 diviſion,

sion, shows the weight of the body put in to be 1095.36 grains. As it thus hangs, let it be immersed in the water of the vessel O, and it will become much lighter: the scale e will descend till the beam of the balance rest on the support z. Then suppose 100 grains put into the scale d restore the equilibrium precisely, so that the index T stand at the 36 division above *a*; it is evident that the weight of an equal bulk of water would, in this case, be exactly 100 grains.

After a like manner this balance may be applied to find the specific gravity of liquids, as is easy to conceive from what has been said.

Balance of Trade. That which is commonly meant by the balance of trade, is the equal importing of foreign commodities with the exporting of the native. And it is reckoned that nation has the advantage in the balance of trade, which exports more of the native commodities, and imports less of the foreign. The reason of this is, that, if the native commodities be of a greater value than are imported, the balance of that account must be made up in bullion or money; and the nation grows so much richer, as the balance of that account amounts to.

Balance of a Clock, or *Watch*, is that part which regulates the beats. See *Clock-Making*.

Balance-Fish. See Squalus, Ichthyology *Index*.

BALANCER, in the history of insects, a style, or oblong body, ending in a protuberance or head, found under each wing of the two-winged flies; these, it is supposed, serve to poise the body of the fly.

BALANCING, among *Seamen*, the contracting a sail into a narrower compass, in a storm, by retrenching, or folding up a part of it at one corner: this method is used in contradistinction to reefing, which is common to all the principal sails; whereas balancing is peculiar to few, such as the mizen of a ship, and the main sail of those vessels wherein it is extended by a boom. See Boom and Reef.—The balance of the mizen is thus performed: the mizen yard is lowered a little, then a small portion of the sail is rolled up at the peek or upper corner, and fastened to the yard about one-fifth inward from the outer end or yard-arm toward the mast. See Mizen.—A boom main-sail is balanced, after all its reefs are taken in, by rolling up a similar portion of the hindmost or aftmost lower corner called the *clue*, and fastening it strongly to the boom, having previously wrapped a piece of old canvass round the part (which is done in both cases) to prevent the sail from being fretted by the cord which fastens it.

BALANUS, the trivial name of a species of lepas. See Lepas, Conchology *Index*.

BALAUSTINES, in *Botany*. See Punica, Botany *Index*.

BALAYAN, a province of the island of Manilla in the East Indies, belonging to the Spaniards.—It lies next to the city of Manilla, and extends along the coast on the east side of the island, a little beyond the bay of Batangas. There were formerly gold mines in it, but they have been long since abandoned. It is inhabited by about 2500 tributary Indians, and abounds in cotton, rice, and palm-trees. The province is well cultivated; and the Spaniards, generally speaking, have country-houses in it.

BALBASTRO, an episcopal town of Spain, in the kingdom of Arragon, and capital of a district of the same name. E. Long. 0. 20. N. Lat. 41. 50.

BALBEC, a city of Asia, in Syria, anciently called *Heliopolis*, and by the Arabians *The wonder of Syria.* It is situated at the foot of Anti-Lebanon, precisely on the last rising ground where the mountain terminates in the plain. As we arrive from the south we discover the city only at the distance of a league and a half, behind a hedge of trees, over the verdant tops of which appears a white edging of domes and minarets. After an hour's journey we reach these trees, which are very fine walnuts; and soon after, crossing some ill cultivated gardens, by winding paths, arrive at the entrance of the city. We there perceive a ruined wall, flanked with square towers, which ascends the declivity to the right, and traces the precincts of the ancient city. This wall, which is only ten or twelve feet high, permits us to have a view of those void spaces and heaps of ruins which are the invariable appendage of every Turkish city; but what principally attracts our attention is a large edifice on the left, which, by its lofty walls and rich columns, manifestly appears to be one of those temples which antiquity has left for our admiration. These ruins, which are some of the most beautiful and best preserved of any in Asia, merit a particular description.

To give a just idea of them, we must suppose ourselves descending from the interior of the town. After having crossed the rubbish and huts with which it is filled, we arrive at a vacant place which appears to have been a square; there, in front, towards the west, we perceive a grand ruin, which consists of two pavilions ornamented with pilasters, joined at their bottom angle by a wall 160 feet in length. This front commands the open country from a sort of terrace, on the edge of which we distinguish with difficulty the bases of twelve columns, which formerly extended from one pavilion to the other, and formed a portico. The principal gate is obstructed by heaps of stones; but, that obstacle surmounted, we enter an empty space, which is a hexagonal court of 180 feet diameter. This court is strewed with broken columns, mutilated capitals, and the remains of pilasters, entablatures, and cornices; around it is a row of ruined edifices, which display all the ornaments of the richest architecture. At the end of this court, opposite the west, is an outlet, which formerly was a gate, through which we perceive a still more extensive range of ruins, whose magnificence strongly excites curiosity. To have a full prospect of these, we must ascend a slope, up which were the steps to this gate; and we then arrive at the entrance of a square court, much more spacious than the former, being 350 feet wide and 336 in length. The eye is first attracted by the end of this court, where six enormous and majestic columns render the scene astonishingly grand and picturesque. Another object not less interesting is a second range of columns to the left, which appear to have been part of the peristyle of a temple; but before we pass thither, we cannot refuse particular attention to the edifices which enclose this court on each side. They form a sort of

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gallery which contains various chambers, ſeven of which may be reckoned in each of the principal wings, viz. two in a ſemicircle and five in an oblong ſquare. The bottom of theſe apartments ſtill retains pediments of niches and tabernacles, the ſupporters of which are deſtroyed. On the ſide of the court they are open, and preſent only four and ſix columns totally deſtroyed. It is not eaſy to conceive the uſe of theſe apartments; but this does not diminiſh our admiration at the beauty of their pilaſters and the richneſs of the frize of the entablature. Neither is it poſſible to avoid remarking the ſingular effect which reſults from the mixture of the garlands, the large foliage of the capitals, and the ſculpture of wild plants with which they are everywhere ornamented. In traverſing the length of the court, we find in the middle a little ſquare eſplanade, where was a pavilion, of which nothing remains but the foundation. At length we arrive at the foot of the ſix columns; and then firſt conceive all the boldneſs of their elevation and the richneſs of their workmanſhip. Their ſhafts are 21 feet eight inches in circumference and 58 high; ſo that the total height, including the entablature, is from 71 to 72 feet. The ſight of this ſuperb ruin, thus ſolitary and unaccompanied, at firſt ſtrikes us with aſtoniſhment; but, on a more attentive examination, we diſcover a ſeries of foundations, which mark an oblong ſquare of 268 feet in length and 146 wide, and which, it ſeems probable, was the periſtyle of a grand temple, the primary purpoſe of this whole ſtructure. It preſented to the great court, that is to the eaſt, a front of ten columns, with 19 on each ſide, which, with the other ſix, make in all 54. The ground on which it ſtood was an oblong ſquare, on a level with this court, but narrower than it, ſo that there was only a terrace of 27 feet wide round the colonnade; the eſplanade this produces fronts the open country toward the weſt, by a ſloping wall of about 30 feet. This deſcent, as you approach the city, becomes leſs ſteep, ſo that the foundation of the pavilion is on a level with the termination of the hill; whence it is evident that the whole ground of the courts has been artificially raiſed. Such was the former ſtate of this edifice; but the ſouthern ſide of the grand temple was afterwards blocked up to build a ſmaller one, the periſtyle and walls of which are ſtill remaining. This temple, ſituated ſomewhat lower than the other, preſents a ſide of 13 columns by eight in front (in all 34), which are likewiſe of the Corinthian order; their ſhafts are 15 feet eight inches in circumference, and 44 in height. The building they ſurround is an oblong ſquare, the front of which, turned towards the eaſt, is out of the line of the left wing of the great court. To reach it you muſt croſs trunks of columns, heaps of ſtone, and a ruinous wall by which it is now hid. After ſurmounting theſe obſtacles you arrive at the gate, where you may ſurvey the encloſure which was once the habitation of a god; but inſtead of the awful ſcene of a proſtrate people and ſacrifices offered by a multitude of prieſts, the ſky is ſeen through the open roof, which lets in light to ſhow a chaos of ruins covered with duſt and weeds. The walls, formerly enriched with all the ornaments of the Corinthian order, now preſent nothing but pediments of niches and tabernacles, of which almoſt all the ſupporters are fallen to the ground. Between theſe niches is a range of fluted pilaſters, whoſe capitals ſupport a broken entablature; but what remains of it diſplays a rich frize of foliage reſting on the heads of ſatyrs, horſes, bulls, &c. Over this entablature was the ancient roof, which was 57 feet wide and 110 in length. The walls which ſupported it are 31 feet high, and without a window. It is impoſſible to form any idea of the ornaments of this roof, except from the fragments lying on the ground; but it could not have been richer than the gallery of the periſtyle: the principal remaining parts contain tablets in the form of lozenges, on which are repreſented Jupiter ſeated on his eagle; Leda careſſed by the ſwan; Diana with her bow and creſcent; and ſeveral buſts which ſeem to be figures of emperors and empreſſes. It would lead us too far to enter more minutely into the deſcription of this aſtoniſhing edifice. The lovers of the arts will find it deſcribed with the greateſt truth and accuracy in a work publiſhed at London in 1757, under the title of *Ruins of Balbec*. This work, compiled by Mr Robert Wood, the world owes to the attention and liberality of Mr Dawkins, who in 1751 viſited Balbec and Palmyra. But ſeveral changes, however, have taken place ſince their journey; for example, they found nine large columns ſtanding, and in 1784 Mr Volney found but ſix. They reckoned 29 at the leſſer temple, but there now remain but 20; the others have been overthrown by the earthquake of 1759. It has likewiſe ſo ſhaken the walls of the leſſer temple, that the ſtone of the ſoffit, or croſs ſtone at the top of the gate, has ſlid between the two adjoining ones, and deſcended eight inches; by which means the body of the bird ſculptured on that ſtone is ſuſpended, detached from its wings and the two garlands which hung from its beak, and terminated in two genii. Nature alone has not effected this devaſtation; the Turks have had their ſhare in the deſtruction of the columns. Their motive is to procure the iron cramps, which ſerve to join the ſeveral blocks of which each column is compoſed. Theſe cramps anſwer ſo well the end intended, that ſeveral of the columns are not even disjointed by their fall; one, among others, as Mr Wood obſerves, has penetrated a ſtone of the temple wall without giving way; nothing can ſurpaſs the workmanſhip of theſe columns; they are joined without any cement, yet there is not room for the blade of a knife between their interſtices. After ſo many ages, they in general ſtill retain their original whiteneſs. But what is ſtill more aſtoniſhing, is the enormous ſtones which compoſe the ſloping wall. To the weſt the ſecond layer is formed of ſtones which are from 28 to 35 feet long, by about nine in height. Over this layer, at the north-weſt angle, there are three ſtones which alone occupy a ſpace of 175½ feet; viz. the firſt 58 feet ſeven inches, the ſecond 58 feet 11, and the third exactly 58 feet; and each of theſe is 12 feet thick. Theſe ſtones are of a white granite, with large ſhining flakes like gypſum; there is a quarry of this kind of ſtone under the whole city and in the adjacent mountain, which is open in ſeveral places, and among others on the right, as we approach the city. There is ſtill lying there a ſtone, hewn on three ſides, which is 69 feet two inches long, 12 feet 10 inches broad, and 13 feet three in thickneſs. By what means could the ancients move theſe enormous maſſes? This is doubt-

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leſs a problem in mechanics curious to reſolve. The inhabitants of Balbec have a very commodious manner of explaining it, by ſuppoſing theſe edifices to have been conſtructed by *Djenoun*, or genii, who obeyed the orders of King Solomon; adding, that the motive of ſuch immenſe works was to conceal in ſubterraneous caverns vaſt treaſures, which ſtill remain there. To diſcover theſe, many have deſcended into the vaults which range under the whole edifice: but the inutility of their reſearches, added to the oppreſſions and extortions of the governors, who have made their ſuppoſed diſcoveries a pretext, have at length diſheartened them; but they imagine the Europeans would be more ſucceſsful, nor would it be poſſible to perſuade them but that we are poſſeſſed of the magic art of deſtroying taliſmans. It is in vain to oppoſe reaſon to ignorance and prejudice: and it would be no leſs ridiculous to attempt to prove to them that Solomon never was acquainted with the Corinthian order, which was only in uſe under the Roman emperors. But their tradition on the ſubject of this prince may ſuggeſt three important obſervations. Firſt, That all tradition relative to high antiquity is as falſe among the Orientals as the Europeans. With them, as with us, facts which happened 100 years before, when not preſerved in writing, are altered, mutilated, or forgotten. To expect information from them with reſpect to events in the time of David or Alexander, would be as abſurd as to make inquiries of the Flemiſh peaſants concerning Clovis or Charlemagne. Secondly, That throughout Syria, the Mahometans, as well as the Jews and Chriſtians, attribute every great work to Solomon: not that the memory of him ſtill remains by tradition in thoſe countries, but from certain paſſages in the Old Teſtament; which, with the goſpel, is the ſource of almoſt all their tradition, as theſe are the only hiſtorical books read or known; but as their expounders are very ignorant, their applications of what they are told are generally very remote from truth. By an error of this kind they pretend Balbec is *the houſe of the foreſt of Lebanon* built by Solomon: nor do they approach nearer probability, when they attribute to that king the well of Tyre and the buildings of Palmyra. Thirdly, That the belief in hidden treaſures has been confirmed by diſcoveries which have been really made from time to time. It is not many years ſince a ſmall coffer was found at Hebron full of gold and ſilver medals, with an ancient Arabic book on medicine. In the country of the Druſes an individual diſcovered likewiſe, ſome time ſince, a jar with gold coin in the form of a creſcent; but as the chiefs and governors claim a right to theſe diſcoveries, and ruin thoſe who have made them, under pretext of obliging them to make reſtoration, thoſe who find any thing endeavour carefully to conceal it; they ſecretly melt the antique coins, nay frequently bury them again in the ſame place where they found them, from the ſame fears which cauſed their firſt concealment, and which prove the ſame tyranny formerly exiſted in theſe countries.

When we conſider the extraordinary magnificence of the temple of Balbec, we cannot but be aſtoniſhed at the ſilence of the Greek and Roman authors. Mr Wood, who has carefully examined all the ancient writers, has found no mention of it except in a fragment of John of Antioch, who attributes the conſtruction of this edifice to Antoninus Pius. The inſcriptions which remain corroborate this opinion, which perfectly accounts for the conſtant uſe of the Corinthian order, ſince that order was not in general uſe before the third age of Rome; but we ought by no means to allege as an additional proof the bird ſculptured over the gate; for if his crooked beak, large claws, and the caduceus he bears, give him the appearance of an eagle, the tuft of feathers on his head, like that of certain pigeons, proves that he is not the Roman eagle: beſides that the ſame bird is found in the temple of Palmyra; and is therefore evidently an Oriental eagle, conſecrated to the ſun, who was the divinity adored in both theſe temples. His worſhip exiſted at Balbec in the moſt remote antiquity. His ſtatue, which reſembled that of Oſiris, had been tranſported there from the Heliopolis of Egypt, and the ceremonies with which he was worſhipped there have been deſcribed by Macrobius, in his curious work entitled *Saturnalia*. Mr Wood ſuppoſes with reaſon, that the name of Balbec, which in Syriac ſignifies *City of Bal*, or of the ſun, originated in this worſhip. The Greeks, by naming it *Heliopolis*, have in this inſtance only given a literal tranſlation of the oriental word: a practice to which they have not always adhered. We are ignorant of the ſtate of this city in remote antiquity; but it is to be preſumed, that its ſituation on the road from Tyre to Palmyra, gave it ſome part of the commerce of theſe opulent capitals. Under the Romans, in the time of Auguſtus, it is mentioned as a garriſon town: and there is ſtill remaining, on the wall of the ſouthern gate, on the right, as we enter, an inſcription which proves the truth of this, the words KENTURIA PRIMA, in Greek characters, being very legible. One hundred and forty years after, Antoninus built there the preſent temple, inſtead of the ancient one, which was doubtleſs falling into ruins: but Chriſtianity having gained the aſcendency under Conſtantine, the modern temple was neglected, and afterwards converted into a church; a wall of which is now remaining, that hid the ſanctuary of the idols. It continued thus until the invaſion of the Arabs, when it is probable they envied the Chriſtians ſo beautiful a building. The church being leſs frequented fell to decay; wars ſucceeded; and it was converted into a place of defence; battlements were built on the wall which ſurrounded it, on the pavilions and at the angles which ſtill ſubſiſt; and from that time, the temple, expoſed to the fate of war, fell rapidly to ruin. The ſtate of the city is not leſs deplorable. The wretched government of the emirs of the houſe of Harfouſhe had already greatly impaired it, and the earthquake of 1759 completed its deſtruction. The wars of the Emir Youſef and Djezzar have rendered it ſtill more deſerted and ruinous. Of 5000 inhabitants, at which number they were eſtimated in 1751, not 1200 are now remaining; and all theſe poor, without induſtry or commerce, and cultivating nothing but a little cotton, ſome maize, and water-melons.

Balbec, Balboa.

BALBINUS, Decimus Coelius, the Roman emperor, being choſen by the ſenate in 237, was maſſacred by the ſoldiers, who had a diſlike to ſuch emperors as were elected only by the ſenators. This prince was eloquent, and wrote pretty good verſes.

BALBOA, Vasco Nugnes de, a Caſtilian; a celebrated

celebrated navigator, and one of the firft difcoverers of South America. He was beheaded by the Spanifh governor of St Mary, through jealoufy of his growing reputation, in 1517, aged 42.

BALBUS, Lucius Cornelius Theophanes, was born at Cadiz, and diftinguifhed himfelf by his valour in the war carried on by the Romans in Spain againft Sertorius and the Lufitanians, on which account Pompey gave him the privileges of a Roman citizen. He was conful in the 714th year of Rome, and was the firft foreigner on whom that dignity was conferred. He was the friend of Pompey, Cæfar, Craffus, and Cicero.—There were many other illuftrious Romans of the name of *Balbus*.

BALCONY, in *Architecture*, a projecture in the front of a houfe, or other building, fupported by pillars or confoles, and encompaffed with a baluftrade.

BALDACHIN, or Baldaquin, in *Architecture*, a building in form of a canopy, fupported by pillars, and frequently ufed as a covering to infulated altars. Some alfo ufe the term *baldachin* for the fhell over a door.

BALDINUCCI, Philip, of Florence; a connoiffeur in the polite arts, and the continuator of Vafari's Lives of the Painters. He died in 1696, aged 72.

BALDIVIA, or Valdivia, a fea-port town of Chili, in America, belonging to the Spaniards. It is fituated between the rivers Callaculles and Portero, where they fall into the South fea. W. Long. 80. 5. S. Lat. 40. 5. It was built in 1551 by the Spanifh general Baldivia, from whom it takes its name. We may judge of its importance from the fum granted annually by the king for maintaining the garrifon and keeping the fortifications in repair, being no lefs than 300,000 pieces of eight. It is defended by four ftrong caftles, mounting 100 pieces of fine brafs cannon. Notwithftanding which, however, as the garrifon is compofed moftly of tranfported criminals, on whom no dependence can be placed, and generally ill fupplied with ammunition, &c. it could make but a poor defence. In 1643 it was eafily taken by the Dutch, who would probably have maintained their conqueft againft all the power of the Spanifh viceroy, had they not been obliged to relinquifh it through ficknefs and famine. The inhabitants of Baldivia amount to about 2000. The trade is lefs confiderable than formerly, becaufe the gold mines in the neighbourhood are fhut up: yet feveral large fhips are employed in the trade between this port and that of Lima, which confifts of gold, corn, hides, and falt provifions, which are exchanged for flaves, fugar, chocolate, and European commodities and manufactures.

BALDNESS, a defect of hair, chiefly on the finciput. It differs from *alopecia*, *area*, *ophiafis*, and *tinea*, as thefe all arife from fome vice in the nutritious humour; *baldnefs*, from the defect of it. When the eyelids fhed their hair, it is called a *ptilofis*. Among the caufes of baldnefs, immoderate venery is reputed one of the chief; old age ufually brings it on of courfe. Some will have the proximate caufe of baldnefs to be the drynefs of the brain, and its fhrinking from the cranium; it having been obferved, that in bald perfons there is always a vacuity or empty fpace between the fkull and the brain.—*Calvus*, *bald-pate*, was a frequent term of reproach among the Romans; among whom this defect was in great difcredit. Hence divers arts to conceal it, as falfe hair, a *galericulus* contrived on purpofe. The later Romans, however, feem to have been reconciled to baldnefs; for we find among them a kind of officers, or fervants, called *glabratores* or *glabrarii*, whofe bufinefs was to take off the hair from all parts, even from the head. In an ancient infcription, there is mention of one Diophantus, TI, CÆSARIS, ornator glabr, that is, *Ornator Glabrarius*.

BALDOC, a town of Hertfordfhire, in England, chiefly noted for its trading in malt. W. Long. 0. 10. N. Lat. 51. 55.

BALDOCK, Ralph de, bifhop of London in the reigns of Edward I. and II. was educated at Merton-college, in Oxford; became dean of St Paul's; was afterwards promoted to the fee of London; and at laft was made lord high chancellor of England. He had a very amiable character both for morals and learning; and wrote *Hiftoria Anglica*, or a Hiftory of the Britifh Affairs down to his own time; and, A Collection of the Statutes and Conftitutions of the church of St Paul. Bifhop Baldock died at Stepney, July 24. 1313.

BALDWIN, archbifhop of Canterbury, was born of obfcure parents at Exeter, where, in the early part of his life, he taught a grammar fchool; after which he took orders, and was made archdeacon of Exeter; but he refigned that dignity, and became a Ciftertian monk in the monaftery of Ford in Devonfhire, of which in a few years he was made abbot. In the year 1180, he was confecrated bifhop of Worcefter. In 1184, he was promoted to the fee of Canterbury by Pope Lucius III. and by his fucceffor Urban III. was appointed legate for that diocefe. He laid the foundation of a church and monaftery in honour of Thomas Becket, at Hackington, near Canterbury, for fecular priefts; but, being oppofed by the monks of Canterbury and the pope, was obliged to defift. In 1190 he crowned King Richard I. at Weftminfter; and foon after followed that prince to the holy land, where he died at the fiege of Ptolemais. Giraldus Cambrenfis, who accompanied him in this expedition, fays, he was of a mild difpofition, and of great abftinence. He wrote various tracts on religious fubjects, which were collected and publifhed by Bertrand Tiffier in 1662.

BALE, John, bifhop of Offory in Ireland, was born at Cove, near Dunwich in Suffolk, in the year 1495. At 12 years of age he was entered in the monaftery of Carmelites at Norwich, and was thence fent to Jefus college in Oxford. He was educated a Roman catholic, but was converted to the Proteftant religion by Thomas Lord Wentworth. On the death of Lord Cromwell, favourite of Henry VIII. who protected him from the perfecutions of the Romifh clergy, he was obliged to retire into the Low Countries, where he continued eight years. Soon after the acceffion of Edward VI. he was recalled; and being firft prefented to the living of Bifhop's Stocke in Hampfhire, in 1552, he was nominated to the fee of Offory. During his refidence in Ireland he was remarkably affiduous in propagating the Proteftant doctrines; but to very little purpofe, and frequently at the hazard of his life. Once, in particular, they murdered five of his domeftics, who were making hay in a meadow near his

his houſe; and would probably have done the ſame by him, if the ſovereign of Kilkenny had not come to his aſſiſtance with 100 horſe and 300 foot. On the acceſſion of Queen Mary, the tide of oppoſition became ſo powerful, that, to avoid aſſaſſination, he embarked for Holland, but was very unfortunate in his eſcape. Firſt he was taken by a Dutch man of war, and robbed by the captain of all his effects. Then, being forced by ſtreſs of weather into St Ive's in Cornwall, he was confined on ſuſpicion of treaſon. Being, however, releaſed after a few days confinement, the ſhip anchored in Dover road, where he was again ſeized on a falſe accuſation. After his arrival in Holland, he was kept priſoner for three weeks, and at length obtained his liberty on paying 30l. From Holland he travelled to Baſil in Switzerland, where he continued till Queen Elizabeth aſcended the throne. After his return to England, he was in 1560 made prebendary of Canterbury, probably not chooſing to return to his former flock of wolves. He died in November 1563, at Canterbury, in the 68th year of his age. He was ſo ſevere a writer againſt the church of Rome, that his books are particularly prohibited in the expurgatory index publiſhed at Madrid, in folio, in the year 1667. He is the earlieſt dramatic writer in the Engliſh language, or at leaſt author of the firſt pieces of that kind that we find in print. Of his writings in that way no fewer than 21 have been enumerated; only three of them, however, have been ſeen in print, viz. 1. God's Promiſes, an interlude; 2. St John Baptiſt, an interlude; 3. Concerning the Laws of Nature corrupted: the firſt of which has been reprinted by Dodſley in the firſt volume of his collection of old plays, and the only copy extant of the laſt is preſerved in St Sepulchre's library in Dublin. As to the reſt, they are mentioned by himſelf as his own, in his account of the writers of Britain before mentioned. He alſo tranſlated the tragedies of Pammachius. His other works are very numerous; but the chief is his catalogue of Britiſh Authors: a book of ſome merit, as it contains ſome information which is not elſewhere to be found; but he has deſtroyed his credit by his intemperate Billingſgate abuſe of all thoſe who differed from him in religion. The authentic part of his work is tranſcribed from Leland. The title of it is, *Illuſtrium Majoris Britanniæ ſcriptorum catalogus, à Japheto ſanctiſſimi Noa filio ad an. Dom.* 1557.

BALE, in *Commerce.* Any goods packed up in cloth, and corded round very tight, in order to keep them from breaking, or preſerve them from the weather, is called a *bale*.—A bale of cotton yarn is from 300 to 400 weight; of raw ſilk, is from 100 to 400; of lockram or dowlas, either three, three and a half, or four pieces.

BALE-Goods, among the Engliſh merchants, are all ſuch as are imported or exported in bales; but the French give that name to certain hardwares and other ſorts of merchandiſe which come to Paris, and are commonly made by bad workmen of indifferent materials.

BALEARES INSULÆ, or the *Balearic Iſlands.* The appellation is commonly derived from Βαλλειν, becauſe the inhabitants were excellent ſlingers. But Bochart makes the name of Punic or Phœnician original, as were the people: *Baal-jare*, a maſter, or ſkilful at throwing; the Phœnicians and Hebrews being dexterous at the uſe of the ſling. The Greeks called theſe iſlands *Gymneſiæ* (Strabo); becauſe in ſummer the inhabitants went naked (Diodorus, Livy), or rather becauſe only armed with a ſling in war (Heſychius). They are two in number, the Greater and the Leſs, or Major and Minor; and hence the modern names *Majorca* and *Minorca.* The Major is diſtant from the Minor 30 miles to the weſt, in length 40 miles, and in circuit 150 (Pliny). They were ſubdued by Quintus Metellus, thence ſurnamed *Balearicus*, in the year 120 B. C. The Baleares, together with the adjacent iſlands, were a part of the Provincia Citerior or Tarraconenſis, and of the reſort of the Conventus Carthaginienſis or New Carthage. Theſe iſlands are called *Choearades* by Apollonius, and *Choeradades* by Strabo, *i. e.* "rocky." See MAJORCA and MINORCA.

BALEARIC ISLANDS. See the preceding article.

BALECHOU, JOHN JOSEPH, a very celebrated and well known French engraver, flouriſhed about 1750. He died, according to Baſan, ſome few years ſince at Avignon. This extraordinary artiſt worked entirely with the graver; and he was perfectly maſter of that inſtrument. The clearneſs of his ſtrokes, and the depth of colour which he produced, are far beyond any production prior to his own. The two large plates which he did from Vernet, one repreſenting a *ſtorm*, the other a *calm*, muſt ever be conſidered as very aſtoniſhing exertions of the artiſt. They are too well known, and too much admired, to need any further eulogium; and were never equalled until they were perhaps ſurpaſſed by our countryman Woollet.

BALEN, HENDRICK VAN, hiſtory and portrait painter, was born at Antwerp in 1560, and was a diſciple of Adam Van Oort; but he quitted that maſter to acquire a better taſte of deſign and compoſition, by purſuing his ſtudies at Rome, where he reſided for a conſiderable time. He copied the antiques; he attended to the works of the moſt memorable modern artiſts; and at his return to his own country, the viſible improvement of his taſte recommended him to the favour and eſteem of the ableſt judges of the art. He diſtinguiſhed himſelf by a good manner of deſigning, and his works are admitted into the cabinets of the curious among thoſe of the principal painters. He particularly excelled in the naked, and gave to his figures ſo much truth, roundneſs, and correctneſs of outline, that few of his cotemporaries could enter into competition with him. Several fine portraits of his hand are at the Hague; among which there is one adorned with allegorical figures of Wiſdom and Juſtice, which extorts commendation from all who attentively conſider it. He died in 1632. All the hiſtorical ſubjects painted by Van Balen have abundant merit. His deſigns of the Deluge, of Moſes ſtriking the Rock, and the drowning of Pharaoh, are grand and noble compoſitions. Houbraken obſerves, that Van Balen with great judgment, hath introduced the Iſraelites in a clear light in the back-ground, but the Egyptians in a ſtrong ſhadow in the fore-ground, which had a very fine effect; the figures being well deſigned, the attitudes and draperies well choſen, and the number of the figures being very conſiderable. Of this painter's hand alſo, the Judgment of Paris is accounted a maſterly performance;

Bales.

performance; in which the figure of Venus is ſo elegantly deſigned, ſo full of life, and ſo round, that it ſeems to ſtand forth from the ſurface. The landſcapes and back-grounds of the pictures compoſed by Van Balen were generally painted by the Velvet Breughel.

Balen, *John Van*, painter of hiſtory, landſcapes, and boys, was born at Antwerp in 1611; and derived his knowledge of the art, and his fine taſte of drawing and deſign, from his father Hendrick Van Balen; but as ſoon as he had made a competent progreſs, he travelled to Rome, and lived for ſeveral years in that and other cities of Italy. There he acquired a good guſto of deſign, though he was ſometimes incorrect; and his particular merit was ſhown in his naked figures of boys, cupids, nymphs bathing or hunting, of which ſubjects he painted a conſiderable number; and he procured both praiſe and riches by his landſcapes and hiſtories. His pictures were well handled, his trees touched with ſpirit, and his herbage and verdure looked natural and lively. The carnations of his figures were clear and freſh; his colouring in general was tranſparent; and the airs of his heads were in the manner of Albano.

BALES, Peter, a famous maſter in the art of penmanſhip, or fair writing; and one of the firſt inventors of ſhort-hand writing. He was born in 1547, and is ſtyled by Anthony Wood "a moſt dexterous perſon in his profeſſion, to the great wonder of ſcholars and others;" who adds, that "he ſpent ſeveral years in ſciences among Oxonians, particularly as it ſeems in Glouceſter-hall: but that ſtudy, which he uſed for a diverſion only, proved at length an employment of profit." He is recorded for his ſkill in micrography, or miniature-writing, in Hollinſhed's Chronicle, anno 1575; and Mr Evelyn alſo has celebrated his wonderful ſkill in this delicate operation of the hand. "Hadrian Junius ſpeaking as a miracle of ſomebody, who wrote the Apoſtles Creed, and the beginning of St John's Goſpel, withing the compaſs of a farthing: what would he have ſaid," ſays Mr Evelyn, "of our famous Peter Bales; who, in the year 1575, wrote the Lord's Prayer, the Creed, Decalogue, with two ſhort prayers in Latin, his own name, motto, day of the month, year of the Lord, and reign of the Queen, to whom he preſented it at Hampton Court, all of it written within the circle of a ſingle penny, inchaced in a ring and borders of gold; and covered with a cryſtal ſo accurately wrought, as to be very plainly legible, to the great admiration of her Majeſty, the whole Privy Council, and ſeveral ambaſſadors then at Court?" He was farther very dexterous in imitating hand-writing, and about 1586, was employed by Secretary Walſingham in certain political manœuvres. We find him at the head of a ſchool, near the Old Bailey, London, in 1590; in which year he publiſhed his "Writing Schoolmaſter, in three parts: the firſt teaching ſwift writing; the ſecond, true writing; the third, fair writing." In 1595, he had a great trial of ſkill in the Black-friars with one Daniel Johnſon, for a golden pen of 20l. value, and won it; and a cotemporary author farther relates, that he had alſo the arms of Calligraphy given him, which are Azure, a Pen, Or, as a prize, at a trial of ſkill in this art among the beſt penmen in London. In 1597, he republiſhed his "Writing Schoolmaſter;" which was in ſuch high reputation, that no leſs than eighteen copies of commendatory verſes compoſed by learned and ingenious men of that time, were printed before it. Wood ſays, that he was engaged in Eſſex's treaſons in 1600; but Wood was miſtaken: he was only engaged, and very innocently ſo, in ſerving the treacherous purpoſes of one of that earl's mercenary dependants. We know little more of this curious perſon, but that he ſeems to have died about the year 1610.

Baleſtra, Baley.

BALESTRA, Antonio, an excellent hiſtorical painter, was born at Verona in 1666. At the age of 21 he went to Venice, where he entered himſelf in the ſchool of Antonio Bellucci, and continued for three years under his direction; but from thence he viſited Bologna and Rome, and at the latter became the diſciple of Carlo Maratti. Under the tuition of ſo eminent a genius, he made a very great proficiency, and exerted himſelf for ſome hours of each day in deſigning after the antiques, after Raphael, Correggio, Hannibal Carracci, and other admired painters; by which conduct he ſo effectually confirmed his taſte and freedom of hand, that he obtained the prize of merit in the Academy of St Luke, in the year 1694, when he was only 28 years of age. From that time his reputation was eſtabliſhed, and he received ſufficient encouragement; being engaged to work for moſt of the churches, and in the palaces of the nobility, and his paintings were admired in every part of Europe. His ſtyle is ſweet and agreeable, not unlike that of Maratti; and the judicious obſerve in the works of Baleſtra, a certain mixture of the ſeveral manners of Raphael, Correggio, and Carracci. He died in 1740. In the church of Santa Maria Mater Domini at Venice, there is one of the moſt capital performances of Baleſtra, repreſenting the nativity of our Saviour. It is deſigned in a grand ſtyle, the compoſition is excellent, and has a great deal of grace. The heads are peculiarly fine; and the whole has a noble effect, with remarkable harmony. In a chapel belonging to the church of S. Geminiano, in the ſame city, there is a dead Chriſt in the arms of the Virgin, painted by this maſter in a grand taſte; and although the compoſition conſiſts but of a few figures, they are finely deſigned; and in every part of it there is ſufficient merit to claim and juſtify applauſe.

BALEY, Walter, the ſon of Henry Baley of Warnwell in Dorſetſhire, was born at Potſham in the ſame county, and educated at Wincheſter ſchool. From thence he was ſent to Oxford; and, after two years probation, was admitted perpetual fellow of New College in the year 1550. Having taken his degrees in arts, he practiſed phyſic, and in 1558 was proctor of the univerſity. About this time he obtained a prebend of Wells, which he reſigned in 1579. In the year 1561 he was appointed queen's profeſſor of phyſic, in 1563 proceeded doctor in that faculty, and afterwards became one of her majeſty's phyſicians in ordinary. He was thought ſkilful in his profeſſion, and had conſiderable practice. He died in 1592, aged 63; and was buried in the inner chapel of New College. His works are, 1. *A diſcourſe of three kinds of paper in common uſe*, 1588, 8vo. 2. *Brief treatiſe of the preſervation of the eye-ſight;* firſt printed in the reign of Elizabeth, in 12mo; afterwards at Oxford in 1616 and 1654, 8vo. 3. *Directions for health natural and artificial;*

tificial; with medicines for all diseases of the eyes, 1626, 4to. 4. *Explicatio Galeni de potu convalescentium et senum*, &c. manuscript, formerly in Lord Aylesbury's library.

BALI, an island of Asia, in the East Indies, forming the north side of the straits of Java, through which the East India ships sometimes return from China to Europe: but the passage is commonly difficult on account of contrary winds. The island is extremely populous, and abounds in rice and other productions peculiar to that climate. The inhabitants are Pagans, and very warlike. E. Long. 115. 30. S. Lat. 9. 0.

BALIOL, or BALLIOL, SIR JOHN DE, founder of Baliol-college in Oxford, was the son of Hugh Baliol, of Bernard's castle, in the diocese of Durham; and was a person very eminent for his power and riches. During the contests and wars between King Henry III. and his barons, he firmly adhered to the king. In 1263, he began the foundation and endowment of Baliol college, which was afterwards perfected by his widow. He died in the year 1269.

BALIOL, BALLIOL, or BOILLIOL, *John*, the competitor with Robert Bruce for the crown of Scotland, was the great grandson of David earl of Huntington, third son of King David I. See SCOTLAND.

BALISORE, a sea-port town of Asia, in the East Indies, to the north-west of the bay of Bengal. It is about four miles from the sea by land, but 20 by the river; seated in a very fruitful soil, producing rice, wheat, aromatic seeds, tobacco, &c. The inhabitants make several sorts of stuffs of cotton, silk, and a kind of grass. The English, French, and Dutch, have factories here; but they are now of no great account. E. Long. 85. 20. N. Lat. 21. 30.

BALISTES. See ICHTHYOLOGY *Index*.

BALIVO AMOVENDO, in *Law*, was a writ for removing a bailiff from his office, for want of having sufficient land in this bailiwick to answer the king and his people, according to the statute of Westminster, 2 reg. Orig. 78.

BALK, among builders, is sometimes used for the summer beam of a house; sometimes for the poles and rafters, which support the roofs of barns, &c.; and sometimes for the beams used in making sea holds.

BALK, or *Balkh*, a province of Great Bukharia in Asia, about 360 miles long and 250 broad, situated to the south of the province of Samarkand, and to the east of Bukharia Proper. It is the least of the three provinces that make up what is called *Great Bukharia;* but being extremely fertile and well cultivated, the prince draws a great revenue from it. The country particularly abounds with silk, of which the inhabitants make pretty manufactures. The Uzbecks subject to the khan of Balkh are the most civilized of all the Tartars inhabiting Great Bukharia, owing probably to their commerce with the Persians: they are likewise more industrious, and more honest, than the rest; but in other respects have the same customs with the rest of the Tartars. The province is subdivided into several counties; the most remarkable of which are Khotlan or Katlan, Tokharestan, and Badagshan. Its chief cities are Balk, Fariyab, Talkhan, Badagshan, and Anderab.

BALK, the capital of the above-mentioned province, situated on the frontiers of Persia, in E. Long. 65. 20. N. Lat. 37. 0. It is probably the ancient Bactra, capital of the kingdom of Bactria; and is said by the Persians to have been founded by Kay-umaraz the first king of Persia, because he met his brother upon the spot where it stood, after he had been lost for a long time; *balkhiden*, or *balghiden*, in the Persic language, signifying to receive and embrace a friend. The first kings of Persia who resided in the province of Media or *Aderbijan*, considered this city as one of their principal frontiers on the side of Scythia. In the 27th year of the Hegira, of Christ 647, Balk was reduced by the Arabs, under the command of Abdallah Ebn Amer. It continued subject to Arab princes till the year of the Hegira 432, of Christ 1041; when it was reduced by Togrol Beg, the Tangrolipix of the Greeks, and prince of the Seljukian dynasty. It was taken by Jenghiz Khan, A. D. 1221, who with his usual and unparalleled cruelty caused all the inhabitants to be brought without the walls and massacred without mercy. In 1369, Sultan Hosein, the last of the race of Jenghiz Khan, was driven from Balk by Tamerlane, whose successors were driven out by the Uzbecks in the 15th century. It was afterwards redeemed by Shah Ismael Sufi; but finally wrested out of his hands by the Uzbeck Tartars, between whom and the Persians it is the occasion of almost continual wars. It was not long since the residence of a khan of Tartars. It is the most considerable city possessed in these parts by the Mahometan Tartars, is large, well built, and populous, the houses consisting for the most part of stone or brick. The fortifications consist of bulwarks of earth, fenced without with a strong wall high enough to cover the soldiers employed in defence of those fortifications. As this place is the resort of all the business transacted between the Indies and Great Bukharia, trade flourishes extremely at Balk; especially as it has a fine river passing through its suburbs, which is of vast service to the town. This river falls into the Amu, in N. Lat. 38. 30. upon the confines of Great Bukharia and Kowarazm. The khan's palace, or castle, is a large edifice built after the oriental manner; and consists almost entirely of marble, of which there are fine quarries in the neighbourhood. The khan of Balk, however, was obliged in 1739 to submit to the Persians under Khouli Kan; but since that time has most probably regained his independency.

BALKERS, in the fishery, persons placed on rocks and eminences at sea to spy the herring droves, and give notice to the fishermen, by waving boughs, what way they go, and where they may be found.

BALL, in a general sense, a spherical and round body, whether naturally so, or formed into that figure by art.

BALL, in the *Military Art*, comprehends all sorts of bullets for fire-arms, from the cannon to the pistol. Cannon-balls are of iron; musket-balls, pistol-balls, &c. are of lead. The experiment has been tried of iron balls for pistols and fusees; but they are justly rejected, not only on account of their lightness, which prevents them from flying straight, but because they are apt to furrow the barrel of the pistol, &c.

BALL of a Pendulum, the weight at the bottom. In shorter pendulums this is called the *bob*.

BALL, in *Pyrotechnics*, is also a composition of various

rious combuſtible ingredients, ſerving to burn, ſmoke, give light, &c. In this ſenſe we read of fire-balls, light-balls, ſmoke-balls, ſtink-balls, ſky-balls, water-balls, land-balls.

Ball, among the Corniſh miners, ſignifies a tin-mine.

Ball, among *Printers*, a kind of wooden tunnel ſtuffed with wool, contained in a leather cover, which is nailed to the wood, with which the ink is applied on the forms to be wrought off. See Printing.

Horſe-Balls, among *Farriers*. Horſes have a very nice taſte; it is therefore proper to give the more diſagreeable drugs in the form of balls, and to make drenches of the more palatable. Balls ſhould be of an oval ſhape, not exceeding the ſize of a pullet's egg; and ſhould be dipped in ſweet oil to make them ſlip down the eaſier. Some horſes have a ſtrait gullet, which makes them very averſe to a ball being thruſt down their throats; ſuch horſes had better have drenches given them, or their medicines may be mixed with bran, or in their maſhes. See Farriery, *paſſim*.

Ball-Vein, in *Mineralogy*, a name given by the miners of Suſſex to a ſort of iron ore common there, and wrought to conſiderable advantage. It yields not any great quantity of metal, but what it has runs freely in the fire; it is uſually found in looſe maſſes, not in the form of a ſtratum, and is often covered with one or more cruſts. It generally contains ſome ſparkling particles; and is uſually of a circular form in the perfect maſſes, thickeſt in the middle, and gradually thinner as it approaches the ſides. The ores of Suſſex in general are poor, but they require very little trouble in the working; ſo that a conſiderable profit is made annually from them.

Ball and Socket, an inſtrument made of braſs, with a perpetual ſcrew, ſo as to move horizontally, vertically, and obliquely; and is generally uſed for the managing of ſurveying or aſtronomical inſtruments.

Puff-Ball, the Engliſh name of the lycoperdon. See Lycoperdon, Botany *Index*.

Martial Balls, in *Pharmacy*, are a mixture of filings of iron and cream of tartar, formed into a ſolid conſiſtence and form of a ball, which is uſed to impregnate water or other liquids with iron diſſolved by the tartareous acid. To make theſe balls, one part of filings of iron and two parts powdered cream of tartar are mixed well together, and put into an earthen or iron veſſel with ſome water. This mixture is to be ſtirred from time to time, till it becomes almoſt dry; and then it is to receive more water, and to be ſtirred as before. This treatment is to be continued till it acquires, when nearly dry, ſomewhat of the conſiſtence and tenacity of ſoftened roſin. Then it is be rolled up in the form of a ball, which is generally kept tied up in rag; and when intended to be uſed, it is to be infuſed in water, till it gives ſome colour to that liquid. The infuſion of martial balls is tonic, vulnerary, diſcutient, and aperitive; and is employed both internally and externally. Iron being ſoluble in all acids, is attacked in this preparation by the tartareous acid, which reduces it to a kind of neutral ſalt not cryſtallizable. This ſalt would remain liquid, and would form a ſoluble martial tartar, called *tartariſed tincture of Mars*. If proper proportions of filings of iron and cream of tartar be uſed, and treated long enough for an entire and complete combination, nothing would be obtained but a liquor or magma, which could not be preſerved in a ſolid form, but would be continually moiſt. Therefore, in the martial ball there is a good deal of the cream of tartar and filings of iron not combined together, by which its ſolidity is preſerved.

Mercurial Balls, in *Pharmacy*, are an amalgam of mercury and tin, ſufficiently ſolid to be moulded, and to preſerve a given form. The method of making them is by adding mercury to melted tin, and pouring the fluid maſs into a round hollow mould. Theſe balls are employed to purify water, in which they are boiled; for which purpoſe travellers often carry ſome along with them. Nothing, however, can be more pernicious than ſuch a practice, ſhould the water contain any nitrous acid, which it very often does.

Balls of Silk-worms and Spiders, are little caſes or cones of ſilk, wherein thoſe inſects depoſite their eggs. Spiders are extremely tender of their balls, which they carry about with them, adhering to the papillæ about their anus. Grew mentions balls or bags of a ſpecies of ſilk-worms in Virginia as big as hens eggs, and containing each four aurelias.

Zoologiſts ſpeak of a ſort of balls of hair covered over with a ſmooth ſhining coat or ſhell, found in the ſtomachs of oxen, cows, calves, horſes, ſheep, and goats. See the article Bezoar.

Balls of Fire, in *Meteorology*. See Fire, *Balls of*.

Balls, in *Electricity*, are two pieces of cork, or pith of elder, nicely turned in a lathe to the ſize of a ſmall pea, and ſuſpended by fine linen threads; intended as electrometers, and of excellent uſe to diſcover ſmall degrees of electricity, to obſerve the changes of it from poſitive to negative, and *vice verſa*; and to eſtimate the force of a ſhock before the diſcharge, ſo that the operator ſhould always be able to tell very nearly before the diſcharge, by knowing how high he has charged his jars, what the exploſion will be.

Fire-Balls, are bags of canvas filled with gunpowder, ſulphur, ſaltpetre, pitch, &c. to be thrown by the ſoldiers, or out of mortars, in order to fire the houſes incommoding trenches, advanced poſts, or the like.—The Greeks had divers kinds of fire-balls, or Πυροβολοι λιθοι; one kind called, more particularly, σκυταλια, or σκυταλιδες, made of wood, ſometimes a foot or even a cubit long; their heads being armed with ſpikes of iron, beneath which were hemp, pitch, and other combuſtibles, which being ſet on fire, they were caſt among the enemy. The preparations of fire-balls, among the moderns, conſiſt of ſeveral operations, viz. making the bag, preparing the compoſition, tying, and, laſtly, dipping the ball. 1. The bags for this purpoſe are either oval or round. 2. The compoſition wherewith fire-balls are filled is various: To ten pounds of meal-gunpowder add two of ſaltpetre, one of ſulphur, and one of colophony; or to ſix pounds of gunpowder, add four of ſaltpetre, four of ſulphur, one of powdered glaſs, half a pound of antimony, as much camphor, an ounce of ſal-ammoniac, and four of common ſalt, all pulveriſed. Sometimes they even fill fire-balls with hand grenades. 3. For tying the fire-balls, they prepare two iron rings, one fitted round the aperture,

aperture, where the ball is to be lighted, the other near its baſe. A cord is tied to theſe rings in ſuch a manner, as that the ſeveral turns repreſent ſemicircles of the ſphere cutting the globe through the poles: over the cords, extended according to the length of the ball, others are tied, cutting the former at right angles, and parallel to each other, making a knot at each interſection: laſtly, after putting in a leaden bullet, the reſt of the ſpace is filled with tow or paper. 4. Thus completed, the fire-ball remains to be dipped in a compoſition of melted pitch four pounds, colophony two, and linſeed oil or oil of turpentine two; after dipping, they cover it round with tow, and dip again, till it be brought to the juſt diameter required.

Light-Balls, are ſuch as diffuſe an intenſe light around; or they are balls which, being caſt out of the hand or a mortar, burn for ſome time, and illuminate the adjacent parts. 1. Luminous or light-balls for the hand are made of ground powder, ſaltpetre, brimſtone, camphor, and borax, all ſprinkled with oil, and moulded into a maſs with ſuet; and this is wrapped up in tow, with a ſheet of ſtrong paper over it. To fire it, they make a hole into it with a bodkin, into which they put ſome priming that will burn ſlow. Its uſe is to be caſt into any works they would diſcover in the night-time. 2. For the larger light-balls, or thoſe to be thrown to a greater diſtance, they melt equal quantities of ſulphur, turpentine, and pitch; and therein dip an earthen or ſtone ball, of a diameter much leſs than that of the mortar out of which the fire-ball is to be caſt: then rolling it in gunpowder, and covering it round with gauze, they dip it again, and repeat the reſt till it come to fit the cavity of the mortar: laſtly, they ſprinkle it around with gunpowder. This, being once kindled, will ſtrongly illuminate all around the place where it is thrown, and give opportunity to examine the ſtate and condition thereof.

Smoke or *Dark-Balls*, thoſe which fill the air with ſmoke, and thus darken a place to prevent diſcoveries. To prepare a darkening ball, make an oval or ſpherical bag; melt roſin over the coals, and add an equal part of ſaltpetre not purified, alſo of ſulphur, and a fifth part of charcoal. The whole being well incorporated, put in tow firſt ſhred, and fill the bags with this compoſition, and dip it after the ſame manner as a fire-ball.

Stink-Balls, thoſe which yield a great ſtench where fired to annoy the enemy. Their preparation is thus: Melt ten pounds of pitch, ſix of roſin, twenty of ſaltpetre, eight of gunpowder, and four of colophony; to theſe add two of charcoal, ſix of horſe-hoofs cut ſmall, three of aſafœtida, one of ſtinking-ſaracen, and any other offenſive ingredients. The reſt as in the former.

Sky-Balls, thoſe caſt on high out of mortars, and which, when arrived at their height, burſting like rockets, afford a ſpectacle of decoration. Sky-balls are made of a wooden ſhell, filled with various compoſitions, particularly that of the ſtars of rockets. Theſe are ſometimes intermixed with crackers and other combuſtibles, making rains of fire, &c.

Water-Balls, thoſe which ſwim and burn a conſiderable time in the water, and at length burſt therein. Theſe are made in a wooden ſhell, the cavity of which is filled with refined ſaltpetre, ſulphur, ſaw-duſt boiled in water of ſaltpetre, and dried; to which ſometimes other ingredients are added, as iron filings, Greek pitch, amber duſt, powdered glaſs, and camphor. The ingredients are to be ground, mixed up, and moiſtened with linſeed oil, nut oil, olive oil, hempſeed oil, or petrol. At the bottom is placed an iron coffin, filled with whole gunpowder, that the ball may at laſt burſt with a greater noiſe: and, laſtly, the ball is by the addition of lead or otherwiſe, made of the ſame ſpecific gravity with water.

Land-Balls are thoſe which, being thrown out of a mortar, fall to the ground, burn, and burſt there. The ingredients are much the ſame as in the *water-balls*, only the ſpecific gravity is not attended to.

BALLAGHAN, a town of Ireland, in the county of Sligo, and province of Connaught. W. Long. 9. 50. N. Lat. 53. 48.

BALLAN, a town of France, in the dioceſe of Mons, ſeated on the river Orne. E. Long. 0. 20. N. Lat. 48. 10.

BALLAD, a kind of ſong, adapted to the capacity of the lower claſs of people; who, being mightily taken with this ſpecies of poetry, are thereby not a little influenced in the conduct of their lives. Hence we find, that ſeditious and deſigning men never fail to ſpread ballads among the people, with a view to gain them over to their ſide.

BALLAST, any heavy matter, as ſtone, gravel, iron, &c. thrown into the hold of a ſhip, in order to make her ſink a proper depth in the water, that ſhe may be capable of carrying a ſufficient quantity of ſail without overſetting.

There is often great difference in the proportion of ballaſt required to prepare ſhips of equal burden for a voyage; the quantity being always more or leſs according to the ſharpneſs or flatneſs of the ſhip's bottom, which ſeamen call the *floor*.

The knowledge of ballaſting a ſhip with propriety, is certainly an article that deſerves the attention of the ſkilful mariner: for although it is known, that ſhips in general will not carry a ſufficient quantity of ſail till they are laden ſo deep that the ſurface of the water will nearly glance on the extreme breadth amidſhips, yet there is more than this general knowledge required; ſince, if ſhe has a great weight of heavy ballaſt, as lead, iron, &c. in the bottom, it will place the centre of gravity too low in the hold; and although this will enable her to carry a great ſail, ſhe will nevertheleſs ſail very heavily, and run the riſk of being diſmaſted by her violent rolling.

To ballaſt a ſhip, therefore, is the art of diſpoſing thoſe materials ſo that ſhe may be duly poiſed, and maintain a proper equilibrium on the water, ſo as neither to be too *ſtiff* nor too *crank*, qualities equally pernicious: as in the firſt, although the ſhip may be fitted to carry a great ſail, yet her velocity will not be proportionably increaſed; whilſt her maſts are more endangered by her ſudden jerks and exceſſive labouring: and in the laſt, ſhe will be incapable of carrying ſail, without the riſk of overſetting.

Stiffneſs, in ballaſting, is occaſioned by diſpoſing a great quantity of heavy ballaſt, as lead, iron, &c. in the bottom, which naturally places the centre of gravity very near the keel; and that being the centre about which

which the vibrations are made, the lower it is placed, the more violent will be the motion of rolling.

Crankneſs, on the other hand, is occaſioned by having too little ballaſt, or by diſpoſing the ſhip's lading ſo as to raiſe the centre of gravity too high, which alſo endangers the maſt in carrying ſail when it blows hard: for when the maſts loſe their perpendicular height, they ſtrain on the ſhrouds in the nature of a lever, which increaſes as the ſine of their obliquity; and a ſhip that loſes her maſts is in great danger of being loſt.

The whole art of ballaſting, therefore, conſiſts in placing the centre of the gravity to correſpond with the trim and ſhape of the veſſel, ſo as neither to be too high nor too low; neither too far forward nor too far aft, and to lade the ſhip ſo deep, that the ſurface of the water may nearly riſe to the extreme breadth amidſhips; and thus ſhe will be enabled to carry a good ſail, incline but little, and ply well to the windward.

Ships are ſaid to be *in ballaſt* when they have no other loading. Maſters of veſſels are obliged to declare the quantity of ballaſt they bear, and to unload it at certain places. They are prohibited unloading their ballaſt in havens, roads, &c. the neglect of which has ruined many excellent ports.—Ships and veſſels taking in ballaſt in the river Thames are to pay ſo much a ton to Trinity-houſe, Deptford; who ſhall employ ballaſtmen, and regulate them; and their lighters to be marked, &c. on pain of 10l.

BALLATOONS, large heavy luggage-boats uſed for carrying wood by the river from Aſtracan and the Caſpian ſea to Moſcow. Theſe will carry from 100 to 200 tons, and have from 100 to 120 men employed to row and tow them along.

BALLENDEN, Sir John, a Scotiſh poet, in the reign of James V. of Scotland, was deſcended from an ancient family in that kingdom. His father, Mr Thomas Ballenden of Auchinoul, was director to the chancery in the year 1540, and clerk regiſter in 1541. Where our poet was educated, we are not informed; but from one of his poems we learn, that in his youth he had ſome employment at the court of King James V. and that he was in great favour with that prince. Having taken orders, and being created doctor of divinity, at the Sorbonne, he was made canon of Roſs, and archdeacon of Moray. He likewiſe obtained the place of clerk-regiſter, but was afterwards deprived of that employment by the factions of the times; however, in the ſucceeding reign of Mary, he recovered that office, and was one of the lords of ſeſſion. Being a zealous papiſt, he, in conjunction with Dr Laing, was extremely aſſiduous in retarding the progreſs of the reformation; till at laſt, finding the oppoſition too powerful, he quitted Scotland, and went to Rome, where he died in the year 1550. He is generally eſteemed one of the beſt Scotiſh poets of that age. His works are, 1. *The hiſtory and chronicles of Scotland of Hector Boëis* (Boethius), *tranſlated by Mr John Ballenden*, Edinb. 1536. This is not a mere tranſlation, Ballenden having corrected ſeveral miſtakes of his author, and made large additions. It is in folio, and black letter. 2. *Coſmography to the hiſtory of Scotland*, with a poetical poem. 3. *A deſcription of Albany*. 4. *Tranſlation of Boethius's deſcription of Scotland*. 5. *Epiſtles to King James V.* Bale ſays he had ſeen theſe letters. 6. Several poems in Carmichael's collection of Scottiſh poems; beſides many others in manuſcript, in private libraries in Scotland. 7. *Virtue and Vyce*, a poem addreſſed to King James V.

BALLET, Balet, or Balletto, a kind of dramatic poem, repreſenting ſome fabulous action or ſubject divided into ſeveral entries; wherein ſeveral perſons appear, and recite things under the name of ſome deity, or other illuſtrious character.

Ballet is more particularly uſed for a kind of comic dance, conſiſting of a ſeries of ſeveral airs of different kinds of movements, which together repreſent ſome ſubject or action. They are performed chiefly by maſks repreſenting ſylvans, tritons, nymphs, ſhepherds, and the like; and conſiſt of three parts, the entry, figure, and the retreat. The word is of Greek origin, formed from βαλλειν, *jacere*, to caſt, throw, or toſs; whence alſo in writers of the middle age, we find *ballationes* for *ſaltationes*, dancings; and *ballare* for *ſaltare*, to dance.

BALLIAGE, or Bailiage, in *Commerce*, a ſmall duty paid to the city of London by aliens, and even denizens, for certain commodities exported by them.

BALLICONNEL, a town of Ireland in the county of Cavan, and province of Ulſter. W. Long. 7. 45. N. Lat. 54. 6.

BALLISHANNON, a large town of Ireland, in the county of Donegal, or Tyrconnel, with a good haven. W. Long. 8. 25. N. Lat. 54. 25.

BALLISTA, a machine uſed by the ancients for ſhooting darts; it reſembled in ſome meaſure our croſs-bow. The word is Latin, ſignifying a croſs-bow; and is derived from the Greek, βαλλω, to *ſhoot*, or *throw*.

Vegetius informs us, that the balliſta diſcharged darts with ſuch rapidity and violence, that nothing could reſiſt their force: and Athenæus adds, that Agiſtratus made one of little more than two feet in length which ſhot darts 500 paces.

In Plate LXXXIV. is repreſented the balliſta uſed in ſieges, according to the chevalier Folard: 2, 2, the baſe of the balliſta; 3, 4, upright beams; 5, 6, tranſverſe beams; 7, 7, the two capitals in the upper tranſverſe beam, (the lower tranſverſe beam has alſo two ſimilar capitals, which cannot be ſeen in this tranſverſe figure); 9, 9, two poſts or ſupports for ſtrengthening the tranſverſe beams; 10, 10, two ſkains of cords faſtened to the capitals; 11, 11, two arms inſerted between the two ſtands, or parts of the ſkains; 12, a cord faſtened to the two arms; 13, darts which are ſhot by the balliſta; 14, 14, curves in the upright beams, and in the concavity of which cuſhions are faſtened, in order to break the force of the arms which ſtrike againſt them with great force when the dart is diſcharged; 16, the arbor of the machine, in which a groove or canal perfectly ſtraight is formed, and in which the darts are placed in order to their being ſhot by the balliſta; 17, the nut of the trigger; 18, the roll or windlaſs, about which the cord is wound; 19, a hook, by which the cord is drawn towards the centre, and the balliſta cocked; 20, a ſtage or table on which the arbor is in part ſuſtained.

BALLISTEUM, or Ballistræa, in antiquity, a military ſong or dance uſed on occaſions of victory. Vopiſcus has preſerved the *baliſteum* ſung in honour of Aurelian, who, in the Sarmatian war, was ſaid to have

have killed 48 of the enemy in one day with his own hand. *Mille, mille, mille mille, mille, mille decollavimus: Unus homo mille, mille, mille, mille decollavit; mille, mille, mille vivat, qui mille, mille occidit. Tantum vini habet nemo, quantum fudit sanguinis.* The same writer subjoins another popular song of the same kind: *Mille Francos, mille Sarmatas, semel occidimus; mille, mille, mille, mille, mille, Persas quærimus.* It took the denomination *ballisteum* from the Greek βαλλω, *jacio*, or *jacto*, to cast or toss, on account of the motions used in this dance, which was attended with great elevations and swingings of the hands. The *ballistæa* were a kind of popular ballads, composed by poets of the lower class, without much regard to the laws of metre.

BALLISTIC PENDULUM, an ingenious machine invented by Benjamin Robins, for ascertaining the velocity of military projectiles, and consequently the force of fired gun-powder. It consists of a large block of wood, annexed to the end of a strong iron stem, having a cross steel axis at the other end, placed horizontally, about which the whole vibrates together like the pendulum of a clock. The machine being at rest, a piece of ordnance is pointed straight towards the wooden block, or ball of this pendulum, and then discharged: the consequence is this; the ball discharged from the gun strikes and enters the block, and causes the pendulum to vibrate more or less according to the velocity of the projectile, or the force of the blow; and by observing the extent of the vibration, the force of that blow becomes known, or the greatest velocity with which the block is moved out of its place, and consequently the velocity of the projectile itself which struck the blow and urged the pendulum. *Hutton's Mathemat. Dict.*

BALLOON, or BALLON, in a general sense, signifies any spherical hollow body, of whatever matter it be composed, or for whatever purposes it be designed. Thus, with chemists, balloon denotes a round short-necked vessel, used to receive what is distilled by means of fire; in architecture, a round globe on the top of a pillar; and among engineers, a kind of bomb made of pasteboard, and played off, in fire-works, either in the air or on the water, in imitation of a real bomb.

Air-BALLOON. See AEROSTATION.

BALLOON also denotes a kind of game something resembling tennis. The balloon is played in the open field, with a great round ball of double leather blown up with wind, and thus driven to and fro with the strength of a man's arm, fortified with a brace of wood.

BALLOON, or BALLOEN, is more particularly used among voyagers for the state-barges of Siam. The balloons are a kind of brigantine, managed with oars, of very odd figures, as serpents, sea-horses, &c. but by their sharpness and number of oars, of incredible swiftness. The balloons are said to be made of a single piece of timber, of uncommon length; they are raised high, and much decorated with carving at head and stern: some are gilt over, and carry 120 or even 150 rowers on each side. The oars are either plated over with silver, or gilt, or radiated with gold; and the dome or canopy in the middle, where the company is placed, is ornamented with some rich stuff, and furnished with a ballustrade of ivory, or other costly matter, enriched with gilding. The edges of the balloon just touch the water, but the extremities rise with a sweep to a great height. Some are adorned with variety of figures, made of pieces of mother-of-pearl inlaid: the richer sort, instead of a dome, carry a kind of steeple in the middle; so that, considering the slenderness of the vessel, which is usually 100 or 120 feet long, and scarce six broad, the height of the two ends, and of the steeple with the load of decorations, it is a kind of miracle they are not overset.

BALLOON, in the French paper-trade, is a term for a quantity of paper, containing 24 reams.

BALLOON, BALLON, or BALLOT, in the French glass-trade, signifies a certain quantity of glass-plates, smaller or greater according to their quality. The ballon of white glass contains 25 bundles, of six plates per bundle; but the ballon of coloured glass is only of $12\frac{1}{2}$ bundles, and of three plates to a bundle.

BALLOTA, WHITE HOREHOUND. See BOTANY *Index.*

BALLOTADE, in the *Manege*, the leap of a horse between two pillars, or upon a straight line, made with justness of time, with the aid of the hand and the calves of the legs: and in such a manner, that when his fore-feet are in the air, he shows nothing but the shoes of his hinder-feet without yerking out.

BALLOTING, a method of voting at elections, &c. by means of little balls usually of different colours, by the French called *ballots;* which are put into a box privately.

BALLS, or BALLETS, in *Heraldry*, a frequent bearing in coats of arms, usually denominated, according to their colour, bezantes, plates, hurts, &c.

BALLUSTER, a small kind of pillar used for ballustrades.

BALLUSTRADE, a series or row of ballusters, joined by a rail; serving as well for a rest to the elbows as for a fence or enclosure to balconies, altars, staircases, &c. See ARCHITECTURE, N° 74.

BALM. See MELISSA, BOTANY *Index.*

BALM, or BALSAM. See BALSAM.

BALM of Gilead. See AMYRIS, BOTANY *Index.*

BALNAVES, HENRY, a Scottish Protestant divine, born in the shire of Fife, in the reign of James V. and educated at the university of St Andrew's. He went afterwards to France in order to finish his studies; and returning to Scotland, was admitted into the family of the earl of Arran, who at that time governed the kingdom: but in the year 1542 the earl dismissed him for having embraced the Protestant religion. In 1564, he joined, says Mackenzie, the murderers of Cardinal Beaton; for which he was declared a traitor, and excommunicated. Whilst that party were besieged in the castle of St Andrew's, they sent Balnaves to England, who returned with a considerable supply of provisions and money; but being at last obliged to surrender to the French, he was sent with the rest of the garrison to France. He returned to Scotland, about the year 1559; and having joined the Congregation, he was appointed one of the commissioners to treat with the duke of Norfolk on the part of Queen Elizabeth. In 1563 he was made one of the lords of session, and appointed by the general assembly, with other learned men, to revise the Book of Discipline. Knox, his cotemporary, and fellow-labourer, gives him the character of a very learned and pious divine. He died

died at Edinburgh in the year 1579. He wrote, 1. *A Treatise concerning Justification.* Edinb. 1550, 8vo. 2. *A Catechism*, or *Confession of Faith.* Edinb. 1584, 8vo.

BALNEARII servi, in antiquity, servants or attendants belonging to the baths. Some were appointed to heat them, called *fornicatores;* others were denominated *capsarii*, who kept the clothes of those that went into them; others *alliptæ*, whose care it was to pull off the hair; others *unctuarii*, who anointed and perfumed the body.

BALNEARIUS fur, in antiquity, a kind of thief who practised stealing the clothes of persons in the baths; sometimes also called *fur balnearum.* The crime of those thieves was a kind of sacrilege; for the hot baths were sacred: hence they were more severely punished than common thieves who stole out of private houses. The latter were acquitted with paying double the value of the thing stolen; whereas the former were punished with death.

BALNEUM, a term used by chemists to signify a vessel filled with some matter, as sand, water, or the like, in which another is placed that requires a more gentle heat than the naked fire.

BALSA, an ancient town of Lusitania, in the Ager Cunæus; now *Tavira*, capital of Algarva.

BALSAM, or Native Balsam, an oily, resinous, liquid substance, flowing either spontaneously, or by means of incision, from certain plants. There are a great variety of balsams, generally denominated from the substances from which they are obtained; and which are explained under their names as they occur.

BALSAMICS. *Balsamica* is a Latin word which signifies *mitigating.* The term *balsamic* is a very lax one; it includes medicines of very different qualities, as emollients, detergents, restoratives, &c. but in medicines of all these kinds there seems to be this requisite in them, viz. that they be soft, yielding, and adhesive, also that by their smallness they have a ready disposition to motion. Medicines of this tribe are generally required for complaints whose seat is in the viscera; and as they cannot be conveyed there but by the common road of the circulation, it follows, that no great effects can be expected from them but by their long continuation. Hoffman calls by the name of *balsamics* those medicines which are hot and acrid, also the natural balsams, gums, &c. by which the vital heat is increased.

Motherby's Med. Dict.

BALSORA. See Bassora.

BALTAGI, among the Turks, porters, and hewers of wood, in the court of the grand signior; who also mount on horseback when the emperor rides out. Part of them also, who, for that purpose, must be castrated, keep watch at the gates of the first and second courts of the seraglio. The first are called *capigi*, and their commander *capigi pascha.*

BALTIC sea, a great gulf surrounded by Sweden, Russia, Courland, Prussia, Pomerania, and Denmark. The king of Denmark levies a tax at Elsineur on every ship that enters the Baltic sea. It is remarkable that this sea neither ebbs nor flows, and there is always a current sets through the Sound into the ocean. It is generally frozen over three or four months in the year. Yellow amber is found in plenty on this coast.

BALTIMORA, in *Botany.* See Botany *Index.*

BALTIMORE, a town of Ireland in the county of Corke, and province of Munster, with the title of a barony. It is seated on a headland which runs into the sea, five miles north-east of Cape Clear. W. Long. 9. 10. N. Lat. 51. 15.

Baltimore, county and town of, Maryland in America.

Baltimore Bird. See Oriolus, Ornithology *Index.*

BALTZAR, Thomas, a native of Lubec, was an eminent musical composer, and esteemed the finest performer on the violin of his time. He came into England in the year 1658, and lived about two years in the house of Sir Anthony Cope of Hanwel in Oxfordshire. He was the great competitor of Davis Mell, who, though a clockmaker by trade, was, till Baltzar came hither, allowed to be the finest performer on the violin in England; and after his arrival he divided with him the public applause, it being agreed that Mell excelled in the fineness of his tone and the sweetness of his manner, and Baltzar in the power of execution and command of the instrument. Moreover, it is said of the latter, that he first taught the English the practice of shifting, and the use of the upper part of the finger-board. Baltzar was given to intemperance, and is said to have shortened his days by excessive drinking: he was buried in Westminister-abbey on the 27th day of July 1663.

BALUCLAVO, or Jambol, a sea-port town of Crimea on the Black sea, where they build ships for the grand signior. E. Long. 35. 15. N. Lat. 44. 50.

BALUZE, Stephen, a French writer, born in 1651, and some time librarian to M. Colbert. In 1693 he obtained a pension, with the post of director of the Royal College, for writing the lives of the popes of Avignon; both which advantages he soon lost in the fluctuation of court parties. M. Baluze is much more noted for collecting ancient MSS. and illustrating them by notes, than famed for his own compositions.

BALYUR, or Baliur, a sea-port of Africa in the kingdom of Dancali, about 14 hours journey west from Babel-Mandel. It is remarkable only for being the landing place of the Abyssinian patriarch Alphonsus Mendez, with his Jesuits and Portuguese, on April 3d 1724. The king, who had received orders from the Abyssinian emperor to give them a proper reception, despatched his son to meet them and conduct them to him. The royal palace they found to consist of about half a dozen of tents, and a score of huts, fenced about with a thorn hedge, and shaded by some wild kinds of trees. Near the palace was a river, which was then quite dried up, and no water to be found but what was digged for in the channel. The hall of audience was only a large tent about a musket-shot from the rest. At the upper end was a kind of throne made of stones and clay, covered with a carpet, and two velvet cushions. At the other end was his majesty's horse, with the saddle and other accoutrements hanging on one side; it being the custom of this country for the master and horse to lie together, whether king or subject. Around the hall were about 50 young men sitting cross-legged; and when the Portuguese ambassadors were admitted, they were made to sit down in the same posture. Soon after came the king preceded by some of his domestics, one having an earthen pitcher full of hydromel, Balzac, Bamba.

hydromel, another a cup made of porcelain, a third carrying a cocoa-ſhell full of tobacco, and a fourth bringing a ſilver tobacco-pipe with ſome fire. Next to them was the king, dreſſed in a light ſilk ſtuff, having on his head a turban, from the rims of which hung a parcel of rings nicely wrought, which dangled before his face. He had in his hand a ſhort kind of javelin, and was followed by all the chief officers of his court and houſehold. The reſpect paid him at his coming in was by ſtanding on their feet, and ſquatting down again twice, after which they went forward to kiſs his hand.

BALZAC, John Lewis Guez de, born at Angouleme in 1595. Voltaire allows him the merit of having given numbers and harmony to the French proſe, but cenſures his ſtyle as ſomewhat bombaſt. The critics of his own time gave him no little diſquiet; and he gave them no little advantage over him by his ſallies of vanity, and ſome particular propoſitions which were a little dangerous. M. Balzac, getting rid of theſe diſputes by his moderation, ſettled at his country-ſeat; refined his ſtyle and genius; and got by his letters and other writings which he publiſhed from time to time, the reputation of being the firſt writer in France. He was at length drawn from his retirement by the hopes of making his fortune under Cardinal Richlieu, who had formerly courted his friendſhip; but in a few years he retired again, diſguſted with the ſlaviſh dependence of a court life. All he obtained from the court was a penſion of 2000 livres, with the titles of counſellor of ſtate and hiſtoriographer of France. He died in 1654; and was buried in the hoſpital of Notre Dame des Anges, to which he bequeathed 12,000 livres. He left an eſtate of 100 franks per annum, for a gold medal to be beſtowed every two years for the beſt diſcourſe on ſome moral ſubject. Beſides his letters he wrote a work called *Oeuvres Diverſes*, i. e. on various ſubjects; The Prince; The Chriſtian Socrates, &c. and many other pieces; all of which have been publiſhed in two vols folio.

BAMBA, a province of the kingdom of Congo in Africa.—It is ſituated between the rivers of Ambriſi and Loſe; the laſt of which parts it from Pemba on the eaſt, as the Ambriſi does from the province of Sogno on the north. Along the ſea-coaſt it extends itſelf northward to the river Lelunda; and on the ſouth to that of Danda, which parts it from the kingdom of Angola. The governors of this province bear the title of *dukes*, and are always ſome of the princes of the royal family. They are as deſpotic and arbitrary as if they were really kings, notwithſtanding the care and pains their monarchs have taken to keep them within due bounds. The ſoil of this province is very fertile; and would produce all the neceſſaries of life in great plenty, were the inhabitants but induſtrious in its cultivation. The ſea-coaſts produce a vaſt quantity of ſalt, which could be purified with little trouble, and would yield an extraordinary revenue if the duties were duly paid; but theſe the governors find means to ſink moſtly into their own coffers.—Here is alſo the fiſhery of the zimbis, or little ſea-ſnail, whoſe ſhell is the current coin not only in this and the neighbouring kingdoms, but alſo in the moſt diſtant parts of Africa. Here are alſo ſaid to be mines of gold, ſilver, quickſilver, copper, tin, and iron; but none except the iron mines are allowed to be worked.

Bamberg, Bamboccio.

BAMBERG, a large handſome town of Franconia in Germany, and capital of a biſhopric of the ſame name. It was formerly imperial, but is now ſubject to the biſhop. The country about it produces plenty of corn, fruits, and liquorice. It has an univerſity, founded in 1585; and is ſituated at the confluence of the rivers Main and Reidnitz. E. Long. 10. 15. N. Lat. 50. 10.

Bamberg, a town of Bohemia, ſituated at the foot of a mountain. E. Long. 16. 50. N. Lat. 49. 53.

BAMBOCCIO, a celebrated painter of converſations, landſcapes, cattle, &c. was born at Laeren, near Narden, in 1613. His name was Peter Van Laer; but in Italy they gave him the name of Bamboccio, on account of the uncommon ſhape of his body, the lower part being one third part longer than the upper, and his neck ſo ſhort that it was buried between his ſhoulders. He had, however, an ample amends for the unſeemlineſs of his limbs, in the ſuperior beauties of his mind: he was endowed with an extenſive genius; and, indeed, had an univerſal taſte for every part of painting. He reſided at Rome for ſixteen years ſucceſſively; every day ſtudying to improve himſelf by thoſe beautiful models which were continually open to his obſervation, and by the lovely ſcenery in the environs of that city. He was held in the higheſt eſteem by all ranks of men, as well as by thoſe of his own profeſſion; not only on account of his extraordinary abilities, but alſo for the amiable qualities of his mind. He ſtudied nature inceſſantly; obſerving with a curious exactneſs every effect of light on different objects, at different hours of the day; and whatſoever incident afforded pleaſure to his imagination, his memory for ever perfectly retained. His ſtyle of painting is ſweet and true; and his touch delicate, with great tranſparency of colouring. His figures are always of a ſmall ſize, well proportioned, and correctly deſigned; and although his ſubjects are taken but from the lower kind of nature, ſuch as plunderings, playing at bowls, inns, farrier ſhops, cattle, or converſations; yet whatever he painted was ſo excellently deſigned, ſo happily executed, and ſo highly finiſhed, that his manner was adopted by many of the Italian painters of his time. His works are ſtill univerſally admired, and he is juſtly ranked among the firſt claſs of the eminent maſters. His hand was as quick as his imagination, ſo that he rarely made ſketches or deſigns for any of his works; he only marked the ſubject with a crayon on the canvas, and finiſhed it without more delay. His memory was amazing: for whatever objects he ſaw, if he conſidered them with any intention to inſert them in his compoſitions, the idea of them was ſo ſtrongly impreſſed on his mind, that he could repreſent them with as much truth as if they were placed before his eyes. Sandrart obſerves, that although painters who are accuſtomed to a ſmall ſize are frequently inaccurate in the diſpoſition of the different parts of their ſubject, ſeeming content if the whole appears natural; yet Bamboccio was as minutely exact in having his figures, trees, grounds, and diſtances, determined with the utmoſt preciſion and perſpective truth, as the beſt maſters uſually are in pictures of the largeſt ſize; which

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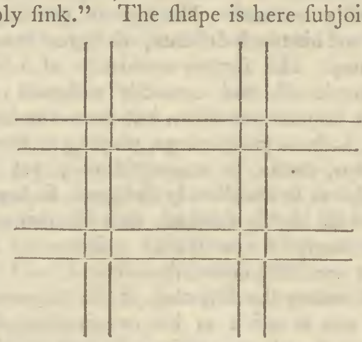
is one circumstance that causes the eye to be so agreeably deluded by the paintings of Bamboccio. In the latter part of his life, he was severely tormented with an asthmatic complaint, which he endured with much impatience; and it is reported, that as the disorder seemed to him unsupportable, he threw himself into a canal to shorten his misery, and was drowned. His death happened in 1673.

BAMBOE, in *Botany*, the trivial name of a species of arundo. See ARUNDO, BOTANY *Index*.

Bamboe-Habit; a Chinese contrivance by which a person who cannot swim may easily keep himself above water. The following account of it is from a letter to the author of the *Seaman's Preservative.* "In the year 1730, I was passenger in a ship from Batavia to China, burden about 400 tons, called the *Pridae*, Francisco Xavier commander, freighted by English, Chinese, and Portuguese. Near the coast of China we met one of those storms called a *tuftoon* (*tau-fong*), or a great wind, which carried away all our masts, bowsprit, and rudder; and in our hold we had six feet of water, expecting every moment the ship would founder.—We consequently were consulting our preservation: the English and Portuguese stood in their shirts only, ready to be thrown off; but the Chinese merchants came upon deck, not in a cork-jacket, but I will call it a *bamboe-habit*, which had lain ready in their chests against such dangers; and it was thus constructed; four bamboes, two before and two behind their bodies, were placed horizontally, and projected about 28 inches. These were crossed on each side by two others, and the whole properly secured, leaving a space for their body; so that they had only to put it over their heads, and tie the same securely, which was done in two minutes, and we were satisfied they could not possibly sink." The shape is here subjoined.



BAMBOROUGH, an inconsiderable village in Northumberland, on the sea coast, 14 miles north of Alnwick, was once a royal borough, and sent two members to parliament: it even gave name to a large tract extending southward, which was called *Bamboroughshire*. It had also three religious foundations; a house of friars preachers founded by Henry III. a cell of canons regular of St Austin, and an hospital. Its very ancient castle stands on an almost perpendicular rock close to the sea, and accessible only on the south-east side, on a spot where, according to the monkish historians, there stood the castle or palace of the kings of Northumberland; built, as it is said, by King Ida, who began his reign about the year 559. Part of the present ruins are by some supposed to be the remains of King Ida's work. The ancient name of this place was, it is said, *Bebbanborough;* which name Camden, from the authority of Bede, imagines borrowed from Bebba, Ida's queen: but the author of the additions to that writer is of a contrary opinion, as in the Saxon copy it is called *Cynclicanberg*, or the "royal mansion." According to Florilegus, King Ida at first fenced it only with a wooden enclosure, but afterwards surrounded it with a wall. It is thus described by Roger Hoveden, who wrote in the year 1192: "Bebba is a very strong city, but not exceeding large; containing not more than two or three acres of ground. It has but one hollow entrance into it, which is admirably raised by steps. On the top of the hill stands a fair church; and in the western point is a well curiously adorned, and of sweat clean water." This castle was besieged anno 642 by Penda, the Pagan king of the Mercians, who, as the story goes, attempted to burn it: for which purpose he laid vast quantities of wood under the walls, and set fire to it as soon as the wind was favourable; but no sooner was it kindled, than by the prayers of St Adian, the wind changed and carried the flames into his camp, so that he was obliged to raise the siege. In 710, King Osred, on the death of Alfred his father, took shelter in this castle with Brithric his tutor or guardian; one Edulph having seized the crown, by whom, with his partizans, they were unsuccessfully besieged. Brithric made so gallant a defence, that the siege was turned into a blockade, which gave the loyal subjects time to arm in defence of their young king. On their marching hither to his relief, Edulph fled; but was followed, taken, and put to death by Brithric, who thereby securely seated Osred on the throne, when this castle became his palace. In the reign of Egbert, Kenulph bishop of Lindisfarne was confined here 30 years from 750 to 780. In 933, it was plundered and totally ruined by the Danes; but being of great importance in defending the northern parts against the continual incursions of the Scots, it was soon after repaired, and made a place of considerable strength. It is said to have been in good repair at the time of the Conquest, when it was probably put into the custody of some trusty Norman, and had in all likelihood some additions made to its works; and this is the more probable, as the present area, contained within its walls, measures upwards of 80 acres, instead of three, as when described by Hoveden. About the year 1095 it was in possession of Robert de Mowbray earl of Northumberland, who engaging in some treasonable practices against William Rufus, that king laid siege to it, and obliged it to surrender. In the next reign it was intrusted by Henry I. to Eustace Fitz-John, who was dispossessed of it and his other employments by King Stephen, that king being jealous of his attachment to Maud, daughter of Henry I. Irritated at this, Fitz-John delivered the castle of Alnwick to David king of Scotland, and brought to his aid all the forces he could raise; he was, however, afterward reconciled to King Stephen, and held the manors of Burg and Knaresborough in Yorkshire, but never recovered the government of this castle.

In the 16th of Henry II. some great repairs seem to have been done here, as in Madox's history of the exchequer, under the article of Amercements, it appears one William, son of Waldef, was fined five marks for refusing his assistance in the king's works at Baenburg castle.

Bamborough.

castle. Its keep is supposed to have been the work of this reign.

Edward I. summoned Baliol to meet him here 1296; and on his refusal invaded Scotland and took him prisoner. Edward II. sheltered Gaveston here 1310. It was taken by the Yorkists after the battle of Hexham. In the reign of Elizabeth Sir John Forester, warden of the marches, was governor of it, and made a knight banneret after the battle of Musselburgh; and his grandson John obtained a grant of both castle and manor from James I. His descendant Thomas forfeited it in 1715; but his maternal uncle Nathaniel Crew bishop of Durham purchased and bequeathed them to unconfined charitable uses. The ruins are still considerable; but many of them are now filled with sand, caught up by the winds which rage here with great violence, and carried to very distant places. The remains of a great hall are very singular; it had been warmed by two fire-places of a vast size, and from the top of every window ran a flue like that of a chimney, which reached the summits of the battlements. These flues seem designed as so many supernumerary chimneys to give vent to the smoke that the immense fires of those hospitable times filled the rooms with; for halls smoky, but filled with good cheer, were in those days thought no inconvenience. In the year 1757, the trustees for Lord Crew's charity began the repairs of the keep or great tower; the direction and management being committed to Dr Sharp archdeacon of Durham, one of their number; who has made a most judicious and humane application of his lordship's generous bequest. The walls are from 9 to 12 feet thick. The upper parts of the building have been formed into granaries; whence, in times of scarcity, corn is sold to the indigent without any distinction at four shillings per bushel. A hall and some small apartments are reserved by the Doctor, who frequently resides here to see that this noble plan is properly executed.—Among the variety of distressed who find relief from the judicious disposition of this charity, are the mariners navigating this dangerous coast, for whose benefit a constant watch is kept on the top of the tower; from whence signals are given to the fishermen of Holy Island when any ship is discovered in distress, these fishermen by their situation being able to put off their boats when none from the land can get over the breakers. The signals are so regulated as to point out the particular place where the distressed vessel lies. Besides which, in every great storm, two men on horseback patrole the adjacent coast from sun-set to sun-rise, who, in case of any shipwreck, are to give immediate notice at the castle. Premiums are likewise paid for the earliest information of any such misfortune. By these means the lives of many seamen have been, and will be, preserved, who would otherwise have perished for want of timely assistance. Nor does this benevolent arrangement stop here. The shipwrecked mariner finds an hospitable reception in this castle; and is here maintained for a week or longer, as circumstances may require. Here, likewise, are store-houses for depositing the goods which may be saved; instruments and tackle for weighing and raising the sunken and stranded vessels; and, to complete the whole, at the expence of this fund, the last offices are decently performed to the bodies of such drowned sailors as are cast on shore.

Bambuck, Bamff.

BAMBUCK, a country of Africa, of which the following account is given by the Abbé Raynal, on the credit of a modern traveller whom he does not name. "In the interior part of Africa, under the 12th or 13th degree of north latitude, there is (says a modern traveller) a pretty large country, known by the name of *Bambuck*. It is not subject to a particular king; but governed by village lords, called *farims*. These hereditary and independent chiefs are all obliged to unite for the defence of the state, when it is either attacked as a community, or only in one of its branches.

"The territory of this aristocratical state is dry and barren. It produces neither maize, rice, nor pulse. The insupportable heat it is subject to, proceeds in part from its being surrounded by high mountains, which prevent the wind from refreshing the air. The climate is as unwholesome as it is disagreeable: vapours, which continually issue from the bowels of a soil replete with minerals, render this country unfit to live in, especially to strangers.

"It is gold that hath made this miserable country an object worthy of notice; gold, which in the eyes of the covetous man seems to compensate for all the evils of nature, though in reality it increases them all. This metal is so common in this country, that it is found almost indiscriminately everywhere. To obtain it, sometimes it is sufficient to scrape the surface of the earth, which is clayish, light, and mixed with sand. When the mine is very rich, it is digged only to the depth of a few feet, and never deeper; though it has been observed, that the lower it was digged, the more gold the soil afforded. The miners are too indolent to pursue a toil which constantly becomes more tedious, and too ignorant to perceive the inconveniences it would be attended with. Their negligence and their folly are in this instance so extraordinary, that in washing the gold, in order to separate it from the earth, they only preserve the larger pieces: the light parts pass away with the water, which flows down an inclined plane.

"The inhabitants of Bambuck do not work these mines at all times, nor are they at liberty to do it when they please. They are obliged to wait till private or public wants determine the farims to grant this permission. When it is proclaimed, all who are able to avail themselves of this advantage meet at the appointed place. When their work is finished, a division is made. Half of the gold goes to the lord, and the remainder is equally distributed among the labourers. Those who want gold at any other time than that of the general digging, search for it in the beds of the rivers, where it is very common.

"The French and English have successively been desirous of appropriating to themselves these real or imaginary riches. Some thought they could reach this country by the Niger, others by the Salum. Far from having succeeded in their attempts of becoming masters of this country, they have not yet ascertained its existence. The unsuccessfulness of past efforts hath redoubled the activity of sanguine minds; sensible and judicious merchants have chosen to limit themselves to a commerce much more important, which is that of slaves."

BAMFF, a shire of Scotland, comprehending part of of Buchan, with the diſtricts of Strathdevron, Boyn, Enzie, Strathaven, and Balvenie, extends 32 miles from eaſt to weſt, and 13 in breadth from north to ſouth. On the ſouth, it is ſeparated from part of Buchan by the river Ugie; on the eaſt it is watered by the Devron and the German ocean; on the weſt it is bounded by the Spey and the county of Murray; on the ſouth-weſt, it borders on Badenoch and the Braes of Mar; and on the north, it is confined by the Murray Frith. The face of the country is agreeably diverſified with hill and dale, not without woods, well watered with rivers, and exhibiting many ſeats and plantations. The air is pure and keen, the climate healthy, and the ſoil fertile, producing plentiful crops of corn. The diſtrict of Buchan, extending northwards from the river Ugie to the ſea, and weſtward as far as Devron, comprehending a tract of 20 miles in length and nine in breadth, is more free from hills and mountains than any other diſtrict of the ſame extent in the kingdom of Scotland. It is inhabited chiefly by Lowlanders, and gives the title of *earl* to the family of Erſkine; of which family, however, Erſkine of Mar is the chief. The county of Bamff abounds with the neceſſaries and comforts of life. The paſture-grounds yield ſheep, cattle, and horſes: the arable lands produce plenty of corn; while the rivers and ſea ſupply great quantities of fiſh. Various minerals have been found in different parts of the ſhire; and a piece of amber, as large as a horſe, was once caſt aſhore on the beach. In the mountainous diſtrict of Balvenie on the weſtern ſide of the ſhire, watered by the Spey, there is a noted rock, which produces hones and whetſtones ſufficient to ſupply the whole iſland. Here are alſo veins of alum ſtone, and ſprings of alum water. Strathallan, another diſtrict to the north-eaſt of Balvenie, abounds with ſuch plenty of limeſtone, that the inhabitants uſe it as common ſtone in building their houſes; and moreover burn a great quantity of it into lime, which they ſell to good advantage in the village of Keith, on the river Devron. Along this whole coaſt, there are ancient Daniſh monuments, ſuch as cairns, tumuli, and huge ſtones ſtanding erect. In Strathaven, a hilly country, lying along the limpid river Aven, which falls into the Spey, we meet with Gordon caſtle, belonging to the duke of Gordon, the moſt princely edifice in the north of Scotland, conſiſting of noble apartments magnificently finiſhed, and environed with fine gardens and parks well ſtored with fallow-deer. The ſame nobleman poſſeſſes ſeveral other ſeats in this county.

The following is the population of the different pariſhes of this county at two different periods:

	Pariſh.	Population in 1755.	Population in 1790—1798.
1	Aberlour	1010	920
	Alva	1161	1070
	Bamff	3000	3510
	Bellie	1730	1919
5	Boharm	835.	1294
	Botriphnie	953	630
	Boyndie	994	1260
	Cullen	900	1214
	Deſkford	940	752
10	Fordyce	3212	3425
	Forglen	607	600
	Gamrie	2083	3000
	Grange	1797	1572
	Inveraven	2464	2244
15	Inverkiethnie	571	460
	Keith	2683	3057
	Kirkmichael	1288	1276
	Marnoch	1894	1960
	Mortlich	2374	1918
20	Ordiquhill	666	517
	Rathven	2898	3524
	Rothiemay	1190	1125
23	St Fergus	1271	1240
		36,521	38,487
			36,521
		Increaſe,	1966

Bamff, the capital of the ſhire of that name in Scotland, is pleaſantly ſituated on the ſide of a hill, at the mouth of the river Devron. It has ſeveral ſtreets; of which that with the town-houſe in it, adorned with a new ſpire, is very handſome. This place was erected into a borough by virtue of a charter from Robert II. dated October 7. 1372, endowing it with the ſame privileges, and putting it on the ſame footing, with the burgh of Aberdeen; but tradition ſays it was founded in the reign of Malcolm Canmore. It gives title of *baron* to a branch of the Ogilvie family. The harbour is very bad, as the entrance at the mouth of the Devron is very uncertain, being often ſtopped by the ſhifting of the ſands, which are continually changing in great ſtorms; the pier is therefore placed on the outſide. Much ſalmon is exported from hence. About Troop-head ſome kelp is made; and the adventurers pay the lord of the manor 50l. per annum for the liberty of collecting the materials. Near the town is a moſt magnificent ſeat lately built by the earl of Fife. It lies in a beautiful plain waſhed by the Devron, the lofty banks of which, clothed with wood on the oppoſite ſide, afford a delightful contraſt to the ſoft vale beneath. W. Long. 2. 5. N. Lat. 57. 40.

BAMIER, the name of a plant common in Egypt. It produces a pyramidal huſk, with ſeveral compartments, of the colour of a lemon, and filled with muſky ſeeds. This huſk dreſſed with meat is a wholeſome food, and has a very agreeable flavour. The Egyptians make great uſe of it in their ragouts.

BAMIYAN, a city of Aſia, ſituated in the province of Zableſtan, 10 days journey from Balkh, and eight from Gazna. It is remarkable only for its dreadful cataſtrophe when taken by Jenghiz Khan in 1221. At that time the city belonged to Sultan Jalalodin, the laſt of the famous Mahmud Gazni's race. Jenghiz Khan was at that time about to attack Gazna, that prince's capital; but was ſtopped by the garriſon of Gazna, which he had hoped would give him no trouble. In this, however, he was diſappointed. The people had for a long time expected an attack; and had therefore ruined the country for five or ſix leagues round, while the peaſants had carried away the ſtones, and every thing that could be of uſe to the beſiegers. Accordingly,

Accordingly, Jenghiz Khan having erected wooden towers, and planted his engines upon them, was in a short time obliged to give over his attacks till millstones and other materials could be brought from a great distance. The walls of the city were very strong, so that the engines of the Moguls made but little impression; and the garrison making frequent and furious sallies, cut off whole squadrons of their enemies, and frequently overthrew their towers and engines. This exceedingly chagrined Jenghiz Khan; who one day returning from a fruitless attack, and hearing of the defeat of one of his generals by Jalallodin, swore to be revenged on Bamiyan. This fury cost the life of one of his grandchildren; who exposing himself too much, to please his grandfather, was slain with an arrow.—At last, however, by the numberless multitude of the Moguls, who continued the attacks without intermission, the city was taken, after its walls had been ruined in many places, and the bravest soldiers and officers of the garrison slain in its defence. The mother of the young prince who had been killed entering with the troops, and more deserving the name of a fiend than a woman, caused the throats of all the inhabitants to be cut, without excepting one. She even gave orders to rip up the bellies of all the women with child, that not an infant might be left alive. In short, to gratify the rage of this inhuman monster, the buildings were all levelled with the ground; the cattle, and every living creature, destroyed; insomuch that the hardened Moguls themselves gave this place the name of *Maubalig*, which in their language signifies *the unfortunate city*. A strong castle has since been built out of its ruins.

BAMOTH-baal, in *Ancient Geography*, one of the towns of the tribe of Reuben, which seems also to have had a temple of Baal on an eminence; lying eastwards, and not far from the river Arnon, and the territory of Moab. Jerome calls it *Bamoth*, a city of the Amorites, beyond Jordan, in the possession of the sons of Reuben. Whether the same with that mentioned Numb. xxi. is doubtful, from the disagreement of interpreters; and yet we may admit it to be the place of encampment of the Israelites, and of Balaam's first station, or where he had the first view of the rear of the people.

BAMPTON, a town of Devonshire, situated in a bottom surrounded with high hills. W. Long. 4. 25. N. Lat. 51. 5.

BAN, or Bans. See Bann.

Ban, in *Commerce*, a sort of fine smooth muslin, which the English import from the East Indies. The piece is almost a yard broad, and runs about 20 yards and a half.

BANANA tree, a species of the musa or plantain. See Musa, Botany *Index*.

BANARES, or Benares, a handsome town of Asia, in the dominions of the Great Mogul, greatly celebrated for its sanctity, and being the university of the Indian Bramins. It is seated on the north side of the river Ganges, in E. Long. 82. 30. N. Lat. 26. 20. See Observatory.

BANBURY, a town of Oxfordshire in England, situated on the river Charwell, in W. Long. 1. 20. N. Lat. 52. 0. It sends one member to parliament.

BANC, or Benca, in *Law*, denotes a tribunal, or judgment-seat; hence *king's banc* is the same with the *court of king's bench*, and *common banc* with that of *common pleas*.

BANCI jus, or the privilege of having a bench, was anciently only allowed to the king's judges, *qui summam administrant justitiam*. Inferior courts, as courts-baron, hundred courts, &c. were not allowed that prerogative; and even at this day the hundred-court at Freibridge in Norfolk is held under an oak at Gey-wood; and that of Woolfry in Herefordshire, under an oak near Ashton in that county, called *Hundred oak*.

BANCA, an island of Asia in the East Indies, between Sumatra and Borneo; from the first of which it is separated only by a narrow channel. This island is famous on account of its tin mines. The prince of the island, who is also possessor of the territory of Palambang on the river of the same name in Sumatra, where he has his constant residence, had a contract with the Dutch by whose troops his authority and independence are preserved, for the tin which he compels his subjects to deliver to him at a low price. Their profit it is said, was not less than 150,000l. annually. In consequence of the perfection which the miners had arrived at in the reduction of the ore, the tin of this island was preferred to the tin from Europe at the Canton market. E. Long. 105. 10. N. Lat. 13. 25.

BANCALIS, a sea-port town on the east coast of the island of Sumatra, where the Dutch have a settlement. E. Long. 99. 7. N. Lat. 1. 5.

BANCK, Peter Vander, an engraver of considerable repute, was born at Paris, and received his instructions in the art from the celebrated Francois de Poilly. He came over into England with Gascar the painter, about the year 1674; and married the sister of a gentleman of estate in Hertfordshire, named Forester. He was a laborious artist: but the pay he received for his plates being by no means adequate to the time he bestowed upon them, he was reduced to want; and, retiring from business, sought an asylum in the house of his brother-in-law. He died at Bradfield, and was buried in the church there, in 1674; leaving his widow in possession of the chief part of his plates, which he disposed of to Brown, a print-seller, to great advantage, and left an easy fortune.—His chief employment was engraving of portraits; and, according to Virtue's account of this artist published by the Hon. Mr Walpole, he was the first in England who engraved them on so large a scale. But even their novelty, it seems, added to their merit, could not sufficiently recommend them to support the artist. Like many of Poilly's disciples, his great merit, according to Mr Strutt, consists in the laboured neatness and management of the mechanical part of the art. Freedom, harmony, and chasteness of outline, are by no means the characteristic of his prints. However, though they cannot rank with the superior productions of Edelink or Nantueil, &c. they have their share of merit; and doubtless will be always esteemed in England, as preserving the best resemblance of many eminent persons who were living at that time.

BANCO, an Italian word which signifies *bank*. It is commonly used to signify the bank of Venice.

BANCOCK, a town of the kingdom of Siam in Asia,

Asia, with a fort, which was once in the possession of the French, but they were driven from it in 1688. E. Long. 101. 5. N. Lat. 13. 25.

BAND, in a general sense, some small narrow ligament, wherewith any thing is bound, tied, or fastened.

Band, in *Architecture*, a general name for any flat low member, or moulding, that is broad but not very deep.

Band of Soldiers, in *Military Affairs*, those who fight under the same flag or ensign.

Band of Pensioners, a company of 120 gentlemen, who receive a yearly allowance of 100l. for attending on his majesty on solemn occasions.

Band is also the denomination of a military order in Spain, instituted by Alphonsus XI. king of Castile, for the younger sons of the nobility; who, before their admission, must serve 10 years at least, either in the army or at court; and are bound to take up arms for the catholic faith against the infidels.

Band, in *Surgery*. See Bandage.

BANDA islands, the general name of five islands in the East Indies, belonging to the Dutch. Two of them are uncultivated, and almost entirely uninhabited; the other three claim the distinction of being the only islands in the world that produce the nutmeg.

If we except this valuable spice, the islands of Banda, like all the Moluccas, are barren to a dreadful degree. What they produce in superfluities they want in necessaries. The land will not bring forth any kind of corn; and the pith of the sago serves the natives of the country instead of bread.

As this food is not sufficient for the Europeans who settle in the Moluccas, they are allowed to fetch provisions from Java, Macassar, or the extremely fertile island of Bali. The company itself carries some merchandise to Banda.

This is the only settlement in the East Indies that can be considered as an European colony; because it is the only one where the Europeans are proprietors of lands. The company finding that the inhabitants of Banda were savage, cruel, and treacherous, because they were impatient under their yoke, resolved to exterminate them. Their possessions were divided among the white people, who got slaves from some of the neighbouring islands to cultivate the lands. These white people are for the most part Creoles, or malecontents who have quitted the service of the country. In the small island of Rosinging, there are likewise several banditti, whom the laws have branded with disgrace; and young men of abandoned principles, whose families wanted to get rid of them: so that Banda is called the *island of correction*. The climate is so unhealthy, that these unhappy men live but a short time. It is on account of the loss of so great a number of hands, that attempts have been made to transfer the culture of the nutmeg to Amboyna; and the company were likewise probably influenced by two other strong motives of interest, as their trade would be carried on with less expence and greater safety. But the experiments that have been made have proved unsuccessful, and matters remain in their former state.

BANDAGE, in *Surgery*, a fillet, roller, or swath, used in dressing and binding up wounds, restraining dangerous hemorrhagies, and in joining fractured and dislocated bones.

BANDALEER, or Bandeleer, in *Military Affairs*, a large leathern belt, thrown over the right shoulder, and hanging under the left arm; worn by the ancient musqueteers, both for the sustaining of their fire-arms, and for the carriage of their musket charges, which being put up in little wooden cases, coated with leather, were hung, to the number of twelve, to each bandaleer.

BANDELET, or Bandlet, in *Architecture*, any little band, or flat moulding, as that which crowns the Doric architrave.

BANDER congo, a small sea-port town in Asia, seated on the Persian gulf. E. Long. 54. 10. N. Lat. 19. 0.

BANDERET, a general, or one of the commanders in chief of the forces.—This appellation is given to the principal commanders of the troops of the canton of Bern in Switzerland, where there are four banderets, who command all the forces of that canton.

BANDEROLL, a little flag, in form of a guidon, extended more in length than in breadth, used to be hung out on the masts of vessels, &c.

BANDITTI, from the Italian *bandito;* persons proscribed, or, as we call it, outlawed: sometimes denominated *banniti* or *foris banniti.* It is also a denomination given to highwaymen or robbers who infest the roads in troops, especially in Italy, France, and Sicily. Mr Brydone, in his Tour through Sicily, informs us, that in the eastern part, called *Val Demoni*, from the devils that are supposed to inhabit Mount Ætna, it has ever been found altogether impracticable to extirpate the banditti; there being numberless caverns and subterraneous passages round that mountain, where no troops could possibly pursue them: besides, they are known to be perfectly determined and resolute, never failing to take a dreadful revenge on all who have offended them. Hence the prince of Villa Franca has embraced it, not only as the safest, but likewise as the wisest and most political scheme, to become their declared patron and protector: and such of them as think proper to leave their mountains and forests, though perhaps only for a time, are sure to meet with good encouragement and a certain protection in his service, where they enjoy the most unbounded confidence, which, in no instance, they have ever yet been found to make an improper or a dishonest use of. They are clothed in the prince's livery, yellow and green, with silver lace; and wear likewise a badge of their honourable order, which entitles them to universal fear and respect from the people.

In some circumstances, these banditti are the most respectable people of the island, and have by much the highest and most romantic notions of what they call their point of honour. However criminal they may be with regard to society in general; yet, with respect to one another, and to every person to whom they have once professed it, they have ever maintained the most unshaken fidelity. The magistrates have often been obliged to protect them, and pay them court, as they are known to be perfectly determined and desperate, and so extremely vindictive, that they will certainly put any person to death that has ever given

given them just cause of provocation. On the other hand, it never was known that any person who had put himself under their protection, and showed that he had confidence in them, had cause to repent of it, or was injured by any of them in the most minute trifle; but, on the contrary, they will protect him from impositions of every kind, and scorn to go halves with the landlord, like most other conductors and travelling servants, and will defend him with their lives if there is occasion. Those of their number who have thus enlisted themselves in the service of society, are known and respected by the other banditti all over the island; and the persons of those they accompany are ever held sacred. For these reasons, most travellers choose to hire a couple of them from town to town; and may thus travel over the whole island in safety.

BANDORA, the capital of the island of Salset, on the west coast of the peninsula on this side the Ganges. It is separated from the island of Bombay by a narrow channel, and subject to the Portuguese. E. Long. 72. 30. N. Lat. 19. 0.

BANDORE, the name of a musical instrument with strings, resembling a lute, and said to be invented in the fourth year of Queen Elizabeth, by John Rose, a citizen of London.

BANDY-LEGS, from the French *bander*, 'to bend,' a distortion of the legs, when they turn either inward or outward on either side; arising from some defect in the birth, or imprudence in the nurse, endeavouring to make a child stand or walk before his legs were strong enough or sustain the weight of his body. See VALGUS.

BANE (from the Saxon *bana*, a murderer), signifies destruction or overthrow. Thus, "I will be the *bane* of such a man," is a common saying. So, when a person receives a mortal injury by any thing, we say, "it was his *bane*:" and he who is the cause of another man's death, is said to be *le bane*, i. e. a malefactor.

BANFF. See BAMFF.

BANGHIR, a town of Ireland, in King's county in the province of Leinster, seated on the river Shannon. W. Long. 8. 5. N. Lat. 53. 10.

BANGLE EARS, an imperfection in a horse, remedied in the following manner. Place his ears in such a manner as you would have them stand; bind them with two little boards so fast that they cannot stir, and then clip away all the empty wrinkled skin close by the head.

BANGIUS, THOMAS, a Danish divine, and an elegant Latin writer on the origin of languages and a variety other subjects. He died in 1661.

BANGOR, an episcopal city of Caernarvonshire in North Wales. In ancient times it was so considerable, that it was called *Bangor the Great*, and defended by a strong castle; but it is now a very mean place; the principal buildings being the cathedral, the bishop's palace, and free school. The see is of very great antiquity, and its founder unknown. The church is dedicated to St Daniel, who was bishop here about the year 516; but for near 500 years afterwards, there is no certainty of the names of his successors. Owen Glendower greatly defaced the cathedral church; but Bishop Dean repaired it again. This see met a still more cruel ravager than Owen Glendower, in the person of Bishop Bulkeley; who not only alienated many of the lands belonging to it, but even sold the bells of the church. This diocese contains the whole of Caernarvonshire except three parishes, the shire of Anglesey, and part of the shires of Denbigh, Merioneth, and Montgomery; in which are 107 parishes, whereof 36 are impropriated. It has three archdeaconries, viz. Bangor, Anglesey, and Merioneth; of which the two first are commonly annexed to the bishopric for its better support. This see is valued in the king's books at 131l. 16s. 4d. and is computed to be worth annually 1200l. The tenths of the clergy are 151l. 14s. 3¼d. To the cathedral there belong a bishop, a dean, an archdeacon, a treasurer, and two prebendaries, endowed; a precentor, a chancellor, and three canons, not endowed; three vicars choral, an organist, lay-clerks, choristers, and two officers. W. Long. 4. 10. N. Lat. 53. 20.

BANGOR, a town of Ireland, in the county of Down and province of Ulster. It is seated on the south shore of the bay of Carrick Fergus, opposite to the town of that name; and sends two members to parliament, W. Long. 6. N. Lat. 54. 42.

BANGUE, a species of opiate, in great use throughout the east, for drowning cares and inspiring joy.—This by the Persians is called *beng*; by the Arabs, *essrar*, corruptly *asseral*, and *assarth*; by the Turks, *bengitie*, and vulgarly called *maslack*; by the European naturalists, *bangue* or *bang*.—It is the leaf of a kind of wild hemp, growing in the countries of the Levant; it differs little, either as to leaf or seed, from our hemp, except in size. Some have mistaken it for a species of althæa.

There are divers manners of preparing it, in different countries. Olearius describes the method used in Persia. Mr Sale tells us, that, among the Arabs, the leaf is made into pills, or conserves. But the most distinct account is that given by Alexander Maurocordato, counsellor and physician of the Ottoman Porte, in a letter to Wedelius. According to this author, bangue is made of the leaves of wild hemp, dried in the shade, then ground to powder; put into a pot wherein butter has been kept; set in an oven till it begin to torrify; then taken out, and pulverized again; thus to be used occasionally, as much at a time as will lie on the point of a knife. Such is the Turkish bangue.—The effects of this drug are, To confound the understanding; set the imagination loose; induce a kind of folly and forgetfulness, wherein all cares are left, and joy and gaiety take place thereof. Bangue, in reality, is a succedaneum to wine, and obtains in those countries where Mahometanism is established; which prohibiting the use of that liquor absolutely, the poor musselmans are forced to have recourse to succedanea, to rouse their spirits. The principal are *opium* and this bangue. As to the opinion among Europeans, that the Turks prepare themselves for battle by a dose of bangue, which rouses their courage, and drives them, with eagerness, to certain death; Dr Maurocordato assures us, that it is a popular error; the Turks think they are then going assuredly to receive the crown of martyrdom; and would not, for any consideration, lose the merit of it, which they would do, by eating the bangue, as being held unlawful by their apostle, among other things which intoxicate.

BANIALUCH, or Bagnaluch, a city of European Turkey, the capital of Bosnia, upon the frontiers of Dalmatia, near the river Setina. E. Long. 18. 20. N. Lat. 44. 20.

BANIAN-tree. See Ficus, Botany *Index*.

BANIANS, a religious sect in the empire of the Mogul, who believe a metempsychosis; and will therefore eat no living creature, nor kill even noxious animals, but endeavour to release them when in the hands of others.—The name of *Banian* is used with some diversity, which has occasioned much confusion, and many mistakes. Sometimes it is taken in a less proper sense, and extended to all the idolaters of India, as contradistinguished from the Mahometans: in which sense, Banians includes the Bramins and other casts. *Banians*, in a more proper sense, is restrained to a peculiar cast, or tribe, of Indians, whose office or profession is trade and merchandise: in which sense, *Banians* stand contradistinguished from *Bramins*, *Cuttery*, and *Wyse*, the three other casts into which the Indians are divided. The four casts are absolutely separate as to occupation, relation, marriage, &c. though all of the same religion; which is more properly denominated the religion of the Bramins, who make the ecclesiastical tribe, than of the *Banians*, who make the mercantile. The proper *Banians* are called, in the *shaster*, or book of their law, by the name of *Shuddery;* under which are comprehended all who live after the manner of merchants, or that deal and transact for others, as brokers; exclusive of the mechanics, or artificers, who make another cast, called *Wyse*. These *Banians* have no peculiar sect or religion, unless it be, that two of the eight general precepts given by their legislator Brama to the Indian nation, are, on account of the profession of the Banians, supposed more immediately to relate to them, viz. those which enjoin veracity in their word and dealings, and avoiding all practices of circumvention in buying and selling. Some of the Banians, quitting their profession, and retiring from the world, commence religious, assume a peculiar habit, and devote themselves more immediately to God, under the denomination of *Vertea*. These, though they do not hereby change their cast, are commonly reckoned as bramins of a more devout kind; much as monks in the Romish church, though frequently not in orders, are reputed as a more sacred order than the regular clergy. The name *Banian* imports as much, in the Bramin language (wherein their law is written), as a people innocent and harmless; void of all guile; so gentle, that they cannot endure to see either a fly or a worm injured; and who, when struck, will patiently bear it, without resisting or returning the blow.—Their mien and appearance is described by Lord *, in terms a little precise, but very significant: "A people presented themselves to my eyes clothed in linen garments, somewhat low descending; of a gesture and garb, as I may say, maidenly, and well nigh effeminate; of a countenance shy and somewhat estranged." Gemelli Careri divides the Banians into 22 tribes, all distinct, and not allowed to marry with each other. Lord assures us they are divided into 82 casts or tribes, correspondent to the casts or divisions of the Bramins or priests, under whose discipline they are as to religious matters; though the generality of the Banians choose to be under the direction of the two Bramin tribes, the Visalnagranaugers and Vulnagranaugers.

* *Discov. Relig. Banian.*

The Banians are the great factors, by whom most of the trade of India is managed; in this respect, comparable to the Jews and Armenians, and not behind either, in point of skill and experience, in whatever relates to commerce. Nothing is bought but by their mediation. They seem to claim a kind of *jus divinum* to the administration of the traffic of the nation, grounded on their sacred books, as the Bramins do that of religion. They are dispersed, for this purpose, through all parts of Asia, and abound in Persia, particularly at Ispahan and Gombroon, where many of them are extremely rich, yet not above acting as brokers, where a penny is to be got. The chief agents of the English, Dutch, and French East India Companies, are of this nation; they are faithful, and are generally trusted with the cash of those companies in their keeping. They act also as bankers, and can give bills of exchange for most cities in the East Indies. Their form of contract in buying and selling is remarkable; being done without words, in the profoundest silence, only by touching each other's fingers: the buyer loosing his pamerin or girdle, spreads it on his knee, and both he and the seller having their hands underneath, by the intercourse of the fingers, mark the price of pounds, shillings, &c. demanded, offered, and at length agreed on. When the seller takes the buyer's whole hand, it denotes a thousand; and, as many times as he squeezes it, as many thousand pagods, or rupees, according to the species in question, are demanded: when he only takes the five fingers, it denotes five hundred; and when only one, one hundred: taking only half a finger, to the second joint, denotes fifty; the small end of the finger, to the first joint, stands for ten.

BANIE, Anthony, licentiate in laws, member of the academy of inscriptions and belles lettres, and ecclesiastic of the diocese of Clermont in Auvergne; died in November 1741, aged 69. He is principally celebrated for his translation of the Metamorphoses of Ovid, with historical remarks and explanations; which was published in 1732, at Amsterdam, in folio, finely ornamented with copperplates, by Picart; and reprinted at Paris 1738, in two vols 4to: and for his Mythology, or Fables of the Ancients, explained by history; a work full of the most important information, which was translated into English, and printed at London in 1741, in 4 vols 8vo.

BANISHMENT, exile, among us is of two kinds: the one voluntary, and upon oath; the other by compulsion, for some offence or crime. The former properly called *abjuration*, is now ceased; the latter is chiefly enjoined by judgment of parliament. Yet outlawing and transportation may also be considered as species of exile.

BANISTER, John, a physician and surgeon in the reign of Queen Elizabeth, was educated at Oxford, where, says Anthony Wood, he studied logicals for a time; but afterwards applied himself solely to physic and surgery. In 1573 he took the degree of bachelor of physic; and, obtaining a license from the university to practise, settled at Nottingham, where he lived many years in great repute, and wrote several medical treatises.

Banisteria || Bank. treatises. His works were collected and published in 1633, 4to.

BANISTERIA. See BOTANY *Index*.

BANK, in *Commerce*, a common repository, where many persons agree to keep their money, to be always ready at their call or direction: or, certain societies or communities, who take the charge of other people's money, either to improve it, or to keep it secure.

The first institution of banks was in Italy, where the Lombard Jews kept benches in the market-places for the exchange of money and bills; and *banco* being the Italian name for *bench*, banks took their title from this word.

I. Company-banks. Banks are of two principal kinds. 1. One sort is either *public*, consisting of a company of moneyed men, who being duly established, and incorporated by the laws of their country, agree to deposite a considerable fund, or joint stock, to be employed for the use of the society, as in lending money upon good security, buying and selling bullion, discounting bills of exchange, &c.: or *private*, i. e. set up by private persons, or partnerships, who deal in the same way as the former upon their own single stock and credit.

Bank of England; its establishment, regulations, importance, &c. The greatest bank of circulation in Europe is the *Bank of England*. The company was incorporated by parliament in the fifth and sixth years of King William and Queen Mary, by the name of *The Governors and Company of the Bank of England*: in consideration of the loan of 1,200,000l. granted to the government; for which the subscribers received almost 8 *per cent*. By this charter, the company are not to borrow under their common seal, unless by act of parliament; they are not to trade, or suffer any person in trust for them to trade, in any goods or merchandise; but they may deal in bills of exchange, in buying or selling bullion, and foreign gold and silver coin, &c.

By an act of parliament passed in the 8th and 9th years of William III. they were empowered to enlarge their capital stock to 2,201,171l. 10s. It was then also enacted, that bank-stock should be a personal, and not a real estate; that no contract either in word or writing for buying or selling bank-stock, should be good in law, unless registered in the books of the bank within 7 days, and the stock transferred in 14 days; and that it shall be felony, without benefit of clergy, to counterfeit the common seal of the bank, or any sealed bank-bill, or any bank-note, or to alter or erase such bills or notes. By another act passed in the 7th of Queen Anne, the company were empowered to augment their capital to 4,402,343l. and they then advanced 400,000 more to the government; and in 1714, they advanced another loan of 1,500,000l.

In the third year of the reign of King George I. the interest of their capital stock was reduced to 5 *per cent*. when the bank agreed to deliver up as many exchequer bills as amounted to 2,000,000l. and to accept an annuity of 100,000l. and it was declared lawful for the bank to call from their members, in proportion to their interests in the capital stock, such sums of money as in a general court should be found necessary. If any member should neglect to pay his share of the moneys so called for, at the time appointed by notice in the London Gazette, and fixed upon the Royal Exchange, it should be lawful for the bank, not only to stop the dividend of such member, and to apply it towards payment of the money in question, but also to stop the transfers of the share of such defaulter, and to charge him with an interest of 5 *per cent. per annum*, for the money so omitted to be paid; and if the principal and interest should be three months unpaid, the bank should then have power to sell so much of the stock belonging to the defaulter as would satisfy the same. After this, the bank reduced the interest of the 2,000,000l. lent to the government, from 5 to 4 *per cent*. and purchased several other annuities, which were afterwards redeemed by the government, and the national debt due to the bank reduced to 1,600,000l. But in 1742, the company engaged to supply the government with 1,600,000l. at 3 *per cent*. which is now called the 3 *per cent. annuities*; so that the government was now indebted to the company 3,200,000l. the one half carrying 4, and the other 3 *per cent*.

In the year 1746, the company agreed that the sum of 986,800l. due to them in the exchequer bills unsatisfied, on the duties for licenses to sell spirituous liquors by retail, should be cancelled, and in lieu thereof to accept of an annuity of 39,442l. the interest of that sum at 4 *per cent*. The company also agreed to advance the further sum of 1,000,000l. into the exchequer, upon the credit of the duties arising by the malt and land tax at 4 *per cent*. for exchequer bills to be issued for that purpose; in consideration of which, the company were enabled to augment their capital with 986,800l. the interest of which, as well as that of the other annuities, was reduced to 3½ *per cent*. till the 25th of December 1757, and from that time to carry only 3 *per cent*.

And in order to enable them to circulate the said exchequer bills, they established what is now called *bank circulation*. The nature of which may be understood from what follows.

The company of the bank are obliged to keep cash sufficient not only to answer the common, but also any extraordinary demand that may be made upon them; and whatever money they have by them, over and above the sum supposed necessary for these purposes, they employ in what may be called the *trade of the company*; that is to say, in discounting bills of exchange, in buying of gold and silver, and in government securities, &c. But when the bank entered into the above-mentioned contract, as they did not keep unemployed a larger sum of money than what they deemed necessary to answer their ordinary and extraordinary demands, they could not conveniently take out of their current cash so large a sum as a million, with which they were obliged to furnish the government, without either lessening that sum they employed in discounting, buying gold and silver, &c. (which would have been very disadvantageous to them), or inventing some method that should answer all the purposes of keeping the million in cash. The method which they chose, and which fully answers their end, was as follows:

They opened a subscription, which they renew annually, for a million of money; wherein the subscribers advance 10 *per cent*. and enter into a contract to pay the remainder, or any part thereof, whenever the bank shall call upon them, under penalty of forfeiting the 10 *per cent*. so advanced; in consideration of which, the bank pays the subscribers 4 *per cent*. interest for the

the money paid in, and $\frac{1}{4}$ *per cent.* for the whole sum they agree to furnish; and in case a call shall be made upon them for the whole, or any part thereof, the bank further agrees to pay them at the rate of 5 *per cent. per annum* for such sum till they repay it, which they are under an obligation to do at the end of the year. By this means the bank obtains all the purposes of keeping a million of money by them; and though the subscribers, if no call is made upon them (which is in general the case), receive $6\frac{1}{2}$ *per cent.* for the money they advance, yet the company gains the sum of 23,500 *per annum* by the contract; as will appear by the following account:

The bank receives from the government for the advance of a million -	£. 30,000
The bank pays the subscribers who advance 100,000l. and engage to pay (when called for) 900,000l. more - -	6,500
The clear gain to the bank thereof is	23,500

This is the state of the case, provided the company should make no call on the subscribers; which they will be very unwilling to do, because it would not only lessen their profit, but affect the public credit in general.

Bank-stock may not improperly be called a *trading stock*, since with this they deal very largely in foreign gold and silver, in discounting bills of exchange, &c. Besides which, they are allowed by the government very considerable sums annually for the management of the annuities paid at their office. All which advantages render a share in their stock very valuable; though it is not equal in value to the East India stock. The company make dividends of the profits half yearly, of which notice is publicly given; when those who have occasion for their money may readily receive it; but private persons, if they judge convenient, are permitted to continue their funds, and to have their interest added to the principal.

This company is under the direction of a governor, deputy-governor, and 24 directors, who are annually elected by the general court, in the same manner as in the East India Company. Thirteen, or more, compose a court of directors for managing the affairs of the company. The officers of this company are very numerous.

The stability of the bank of England is equal to that of the British government. All that it has advanced to the public must be lost before its creditors can sustain any loss. No other banking company in England can be established by act of parliament, or can consist of more than six members. It acts, not only as an ordinary bank, but (as we have already seen) as a great engine of state; receiving and paying the greater part of the annuities which are due to the creditors of the public; circulating exchequer bills; and advancing to government the annual amount of the land and malt taxes, which are frequently not paid up till some years thereafter. It likewise has, upon several different occasions, supported the credit of the principal houses, not only in England, but of Hamburgh and Holland. Upon one occasion it is said to have advanced for this purpose, in one week, about 1,600,000l. a great part of it in bullion.

Scotch banks, public and private.

In Scotland there are two public banks, both at Edinburgh. The one, called *The Bank of Scotland*, was established by act of parliament in 1695; the other, called *The Royal Bank*, by royal charter in 1727.

Within these 30 years there have also been erected private banking companies in almost every considerable town, and even in some villages. Hence the business of the country is almost entirely carried on by paper-currency, *i. e.* by the notes of those different banking companies; with which purchases and payments of all kinds are commonly made. Silver very seldom appears, except in the change of a twenty-shilling bank-note, and gold still seldomer. But though the conduct of all those different companies has not been unexceptionable, and has accordingly required an act of parliament to regulate it; the country, notwithstanding, has evidently derived great benefit from their trade. It has been asserted, that the trade of the city of Glasgow doubled in about 15 years after the first erection of the banks there; and that the trade of Scotland has more than quadrupled since the first erection of the two public banks at Edinburgh. Whether the trade, either of Scotland in general, or of the city of Glasgow in particular, has really increased in so great a proportion, during so short a period, we do not pretend to know. If either of them has increased in this proportion, it seems to be an effect too great to be accounted for by the sole operation of this cause. That the trade and industry of Scotland, however, have increased very considerably during this period, and that the banks have contributed a good deal to this increase, cannot be doubted.

Smith's Wealth of Nations, Book II. chap. ii.

The value of the silver money which circulated in Scotland before the Union in 1707, and which immediately after it was brought into the bank of Scotland in order to be recoined, amounted to 411,117l. 10s. 9d. Sterling. No account has been got of the gold coin: but it appears from the ancient accounts of the mint of Scotland, that the value of the gold annually coined somewhat exceeded that of the silver. There were a good many people too upon this occasion, who, from a diffidence of repayment, did not bring their silver into the bank of Scotland; and there was, besides, some English coin, which was not called in. The whole value of the gold and silver, therefore, which circulated in Scotland before the Union, cannot be estimated at less than a million Serling. It seems to have constituted almost the whole circulation of that country; for though the circulation of the bank of Scotland, which had then no rival, was considerable, it seems to have made but a very small part of the whole. In the present times, the whole circulation of Scotland cannot be estimated at less than two millions, of which that part which consists of gold and silver most probably does not amount to half a million. But though the circulating gold and silver of Scotland have suffered so great a diminution during this period, its real riches and prosperity do not appear to have suffered any. Its agriculture, manufactures, and trade, on the contrary, the annual produce of its land and labour, have evidently been augmented.

Discounting of bills.

It is chiefly by discounting bills of exchange, that is, by advancing money upon them before they are due, that the greater part of banks and bankers issue their promissory notes. They deduct always upon whatever

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ever ſum they advance, the legal intereſt till the bill ſhall become due. The payment of the bill, when it becomes due, replaces to the bank the value of what had been advanced, together with a clear profit of the intereſt. The banker, who advances to the merchant whoſe bill he diſcounts not gold and ſilver, but his own promiſſory notes, has the advantage of being able to diſcount to a greater amount, by the whole value of his promiſſory notes, which he finds by experience are commonly in circulation. He is thereby enabled to make his clear gain of intereſt on ſo much larger a ſum.

The commerce of Scotland, which at preſent is not very great, was ſtill more inconſiderable when the two firſt banking companies were eſtabliſhed; and thoſe companies would have had but little trade, had they confined their buſineſs to the diſcounting of bills of exchange. They invented, therefore, another method of iſſuing their promiſſory notes, by granting what they called *caſh-accounts;* that is, by giving credit to the extent of a certain ſum (2000l. or 3000l. for example), to any individual who could procure two perſons of undoubted credit and good landed eſtate to become ſurety for him, that whatever money ſhould be advanced to him within the ſum for which the credit had been given ſhould be repaid upon demand, together with the legal intereſt. Credits of this kind are commonly granted by banks and bankers in all different parts of the world. But the eaſy terms on which the Scots banking companies accept of repayment are peculiar to them, and have perhaps been the principal cauſe, both of the great trade of thoſe companies and of the benefit which the country has received from it.

Caſh-accounts.

Advantages from theſe

Whoever has a credit of this kind with one of thoſe companies, and borrows 1000l. upon it, for example, may repay this ſum piecemeal, by 20l. and 30l. at a time, the company diſcounting a proportionable part of the intereſt of the great ſum from the day on which each of thoſe ſmall ſums is paid in, till the whole be in this manner repaid. All merchants, therefore, and almoſt all men of buſineſs, find it convenient to keep ſuch caſh-accounts with them; and are thereby intereſted to promote the trade of thoſe companies, by readily receiving their notes in all payments, and by encouraging all thoſe with whom they have any influence to do the ſame. The banks, when their cuſtomers apply to them for money, generally advance it to them in their own promiſſory notes. Theſe the merchants pay away to the manufacturers for goods, the manufacturers to the farmers for materials and proviſions, the farmers to their landlords for rent, the landlords repay them to the merchants for the conveniences and luxuries with which they ſupply them, and the merchants again return them to the banks in order to balance their caſh-accounts, or to replace what they may have borrowed of them; and thus almoſt the whole money-buſineſs of the country is tranſacted by means of them. Hence the great trade of thoſe companies.

to the banks, and

By means of thoſe caſh-accounts, every merchant can, without imprudence, carry on a greater trade than he otherwiſe could do. If there are two merchants, one in London and the other in Edinburgh, who employ equal ſtocks in the ſame branch of trade, the Edinburgh merchant can, without imprudence, carry on a greater trade, and give employment to a greater number of people, than the London merchant. The London merchant muſt always keep by him a conſiderable ſum of money, either in his own coffers, or in thoſe of his banker (who gives him no intereſt for it), in order to anſwer the demands continually coming upon him for payment of the goods which he purchaſes upon credit. Let the ordinary amount of this ſum be ſuppoſed 500l. The value of the goods in his warehouſe muſt always be leſs by 500l. than it would have been, had he not been obliged to keep ſuch a ſum unemployed. Let us ſuppoſe that he generally diſpoſes of his whole ſtock upon hand, or of goods to the value of his whole ſtock upon hand, once in the year. By being obliged to keep ſuch a great ſum unemployed, he muſt ſell in a year 500l. worth leſs goods than he might otherwiſe have done. His annual profits muſt be leſs by all that he could have made by the ſale of 500l. worth more goods; and the number of people employed in preparing his goods for the market, muſt be leſs by all thoſe that 500l. more ſtock could have employed. The merchant in Edinburgh, on the other hand, keeps no money unemployed for anſwering ſuch occaſional demands. When they actually come upon him, he ſatisfies them from his caſh-account with the bank, and gradually replaces the ſum borrowed with the money or paper which comes in from the occaſional ſales of his goods. With the ſame ſtock, therefore, he can, without imprudence, have at all times in his warehouſe a larger quantity of goods than the London merchant; and can thereby both make a greater profit himſelf, and give conſtant employment to a greater number of induſtrious people who prepare thoſe goods for the market. Hence the great benefit which the country has derived from this trade.

to the country.

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The late multiplication of banking companies in both parts of the united kingdom, an event by which many people have been much alarmed, inſtead of diminiſhing, increaſes the ſecurity of the public. It obliges all of them to be more circumſpect in their conduct, and, by not extending their currency beyond its due proportion to their caſh, to guard themſelves againſt thoſe malicious runs which the rivalſhip of ſo many competitors is always ready to bring upon them. It reſtrains the circulation of each particular company within a narrower circle, and reduces their circulating notes to a ſmaller number. By dividing the whole circulation into a greater number of parts, the failure of any one company, an accident which, in the courſe of things, muſt ſometimes happen, becomes of leſs conſequence to the public. This free competition too obliges all bankers to be more liberal in their dealings with their cuſtomers, leſt their rivals ſhould carry them away. In general, if any branch of trade, or any diviſion of labour, be advantageous to the public, the freer and more general the competition, it will always be the more ſo. See further, the article PAPER-*money*.

2. The other kind of banks conſiſt of ſuch as are inſtituted wholly on the public account, and are called *Banks of Depoſit;* the nature of which not being generally underſtood, the following particular explanation may not be unacceptable.

II. Banks of depoſit.

The currency of a great ſtate, ſuch as Britain, generally

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Smith's Wealth of Nations. Book IV. chap. iii.

nerally conſiſts almoſt entirely of its own coin. Should this currency, therefore, be at any time worn, clipt, or otherwiſe degraded below its ſtandard value, the ſtate by a reformation of its coin can effectually re-eſtabliſh its currency. But the currency of a ſmall ſtate, ſuch as Genoa or Hamburgh, can ſeldom conſiſt altogether in its own coin, but muſt be made up, in a great meaſure, of the coins of all the neighbouring ſtates with which its inhabitants have a continual intercourſe. Such a ſtate, therefore, by reforming its coin, will not always be able to reform its currency. If foreign bills of exchange are paid in this currency, the uncertain value of any ſum, of what is in its own nature ſo uncertain, muſt render the exchange always very much againſt ſuch a ſtate, its currency being, in all foreign ſtates, neceſſarily valued even below what it is worth. In order to remedy the inconvenience to which this diſadvantageous exchange muſt have ſubjected their merchants, ſuch ſmall ſtates, when they began to attend to the intereſt of trade, have frequently enacted, that foreign bills of exchange of a certain value ſhould be paid, not in common currency, but by an order upon, or by a transfer in, the books of a certain bank, eſtabliſhed upon the credit and under the protection of the ſtate; this bank being always obliged to pay, in good and true money, exactly according to the ſtandard of the ſtate. The banks of Venice, Genoa, Amſterdam, Hamburgh, and Nuremberg, ſeem to have been all originally eſtabliſhed with this view, though ſome of them may have afterwards been made ſubſervient to other purpoſes. The money of ſuch banks, being better than the common currency of the country, neceſſarily bore an agio, which was greater or ſmaller, according as the currency was ſuppoſed to be more or leſs degraded below the ſtandard of the ſtate. The agio of the bank of Hamburgh, for example, which is ſaid to be commonly about 14 *per cent.* is the ſuppoſed difference between the good ſtandard money of the ſtate, and the clipt, worn, and diminiſhed currency poured into it from all the neighbouring ſtates.

Bank of Amſterdam, one of the moſt famous. Its inſtitution, regulation, utility, &c.

Before 1609, the great quantity of clipt and worn foreign coin, which the extenſive trade of Amſterdam brought from all parts of Europe, reduced the value of its currency about 9 *per cent.* below that of good money freſh from the mint. Such money no ſooner appeared, that it was melted down or carried away, as it always is in ſuch circumſtances. The merchants, with plenty of currency, could not always find a ſufficient quantity of good money to pay their bills of exchange; and the value of thoſe bills, in ſpite of ſeveral regulations which were made to prevent it, became in a great meaſure uncertain. In order to remedy theſe inconveniences, a bank was eſtabliſhed in 1609 under the guarantee of the city. The bank received both foreign coin, and the light and worn coin of the country, at its real and intrinſic value in the good ſtandard money of the country, deducting only ſo much as was neceſſary for defraying the expence of coinage, and other neceſſary expence of management. For the value which remained after this ſmall deduction was made, it gave a credit in its books. This credit was called *bank-money;* which, as it repreſented money exactly according to the ſtandard of the mint, was always of the ſame real value, and intrinſically worth more than current money. It was at the ſame time enacted, that all bills drawn upon or negociated at Amſterdam of the value of 600 guilders and upwards ſhould be paid in bank-money, which at once took away all uncertainty in the value of thoſe bills. Every merchant, in conſequence of this regulation, was obliged to keep an account with the bank in order to pay his foreign bills of exchange, which neceſſarily occaſioned a certain demand for bank-money.

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Bank-money, over and above both its intrinſic ſuperiority to currency, and the additional value which this demand neceſſarily gives it, has likewiſe ſome other advantages. It is ſecure from fire, robbery, and other accidents; the city of Amſterdam is bound for it; it can be paid away by a ſimple transfer, without the trouble of counting, or the riſk of tranſporting it from one place to another. In conſequence of thoſe different advantages, it ſeems from the beginning to have borne an agio; and it is generally believed that all the money originally depoſited in the bank was allowed to remain there, nobody caring to demand payment of a debt which he could ſell for a premium in the market. Beſides, this money could not be brought from thoſe coffers, as it will appear by and by, without previouſly paying for the keeping.

Thoſe depoſits of coin, or which the bank was bound to reſtore in coin, conſtituted the original capital of the bank, or the whole value of what was repreſented by what is called *bank money.* At preſent they are ſuppoſed to conſtitute but a very ſmall part of it. In order to facilitate the trade in bullion, the bank has been for theſe many years in the practice of giving credit in its books upon depoſits of gold and ſilver bullion. This credit is generally about 5 *per cent.* below the mint price of ſuch bullion. The bank grants at the ſame time what is called a *recipice* or receipt, entitling the perſon who makes the depoſit, or the bearer, to take out the bullion again at any time within ſix months, upon re-transferring to the bank a quantity of bank-money equal to that for which credit had been given in its books when the depoſit was made, and upon paying $\frac{1}{4}$ *per cent.* for the keeping if the depoſit was in ſilver, and $\frac{1}{2}$ *per cent.* if it was in gold; but at the ſame time declaring, that in default of ſuch payment, and upon the expiration of this term, the depoſit ſhould belong to the bank at the price at which it had been received, or for which credit had been given in the transfer books. What is thus paid for the keeping of the depoſit may be conſidered as a ſort of warehouſe-rent; and why this warehouſe-rent ſhould be ſo much dearer for gold than for ſilver, ſeveral different reaſons have been aſſigned. The fineneſs of gold, it has been ſaid, is more difficult to be aſcertained than that of ſilver. Frauds are more eaſily practiſed, and occaſion a greater loſs in the more precious metal. Silver, beſides, being the ſtandard metal, the ſtate, it has been ſaid, wiſhes to encourage more the making of depoſits of ſilver than thoſe of gold.

Depoſits of bullion are moſt commonly made when the price is ſomewhat lower than ordinary; and they are taken out again when it happens to riſe. In Holland the market price of bullion is generally above the mint price, for the ſame reaſon that it was ſo in England before the late reformation of the gold coin. The difference is ſaid to be commonly from about ſix to ſixteen

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The perſon who by making a depoſit of bullion obtains both a bank-credit and a receipt, pays his bills of exchange as they become due with his bank-credit; and either ſells or keeps his receipt, according as he judges that the price of bullion is likely to riſe or to fall. The receipt and the bank-credit ſeldom keep long together, and there is no occaſion that they ſhould. The perſon who has a receipt, and who wants to take out bullion, finds always plenty of bank-credits, or bank-money, to buy at the ordinary price; and the perſon who has bank-money, and wants to take out bullion, finds receipts always in equal abundance.

The owners of bank-credits and the holders of receipts conſtitute two different ſorts of creditors againſt the bank. The holder of a receipt cannot draw out the bullion for which it is granted, without re-aſſigning to the bank a ſum of bank-money equal to the price at which the bullion had been received. If he has no bank-money of his own, he muſt purchaſe it of thoſe who have it. The owner of bank-money cannot draw out bullion without producing to the bank receipts for the quantity which he wants. If he has none of his own, he muſt buy them of thoſe who have them. The holder of a receipt, when he purchaſes bank-money, purchaſes the power of taking out a quantity of bullion, of which the mint-price is 5 *per cent.* above the bank-price. The agio of 5 *per cent.* therefore, which he commonly pays for it, is paid, not for an imaginary, but for a real value. The owner of bank-money, when he purchaſes a receipt, purchaſes the power of taking out a quantity of bullion, of which the market-price is commonly from 2 to 3 *per cent.* above the mint-price. The price which he pays for it, therefore, is paid likewiſe for a real value. The price of the receipt, and the price of the bank-money, compound or make up between them the full value or price of the bullion.

Upon depoſits of the coin current in the country, the bank grants receipts likewiſe as well as bank-credits; but thoſe receipts are frequently of no value, and will bring no price in the market. Upon ducatoons, for example, which in the currency paſs for three gilders three ſtivers each, the bank gives a credit of three gilders only, or 5 *per cent.* below their current value. It grants a receipt likewiſe entitling the bearer to take out the number of ducatoons depoſited at any time within ſix months, upon paying $\frac{1}{4}$ *per cent.* for the keeping. This receipt will frequently bring no price in the market. Three gilders bank-money generally ſell in the market for three gilders three ſtivers, the full value of the ducatoons if they were taken out of the bank; and before they can be taken out, $\frac{1}{4}$ *per cent.* muſt be paid for the keeping, which would be mere loſs to the holder of the receipt. If the agio of the bank, however, ſhould at any time fall to 3 *per cent.* ſuch receipts might bring ſome price in the market, and might ſell for $1\frac{3}{4}$ *per cent.* But the agio of the bank being now generally about 5 *per cent.* ſuch receipts are frequently allowed to expire, or, as they expreſs it, to fall to the bank. The 5 *per cent.* which the bank gains, when depoſits either of coin or bullion are allowed to fall to it, may be conſidered as the warehouſe rent for the perpetual keeping of ſuch depoſits.

The ſum of bank-money for which the receipts are expired muſt be very conſiderable. It muſt comprehend the whole original capital of the bank, which, it is generally ſuppoſed, has been allowed to remain there from the time it was firſt depoſited, nobody caring either to renew his receipt or to take out his depoſit, as, for the reaſons already aſſigned, neither the one nor the other could be done without loſs. But whatever may be the amount of this ſum, the proportion which it bears to the whole maſs of bank-money is ſuppoſed to be very ſmall. The bank of Amſterdam has for theſe many years paſt been the great warehouſe of Europe for bullion, for which the receipts are very ſeldom allowed to expire, or, as they expreſs it, to fall to the bank. The far greater part of the bank-money, or of the credits upon the books of the bank, is ſuppoſed to have been created, for theſe many years paſt, by ſuch depoſits which the dealers in bullion are continually both making and withdrawing.

No demand can be made upon the bank but by means of a recipice or receipt. The ſmaller maſs of bank-money, for which the receipts are expired, is mixed and confounded with the much greater maſs for which they are ſtill in force; ſo that, though there may be a conſiderable ſum of bank-money for which there are no receipts, there is no ſpecific ſum or portion of it which may not at any time be demanded by one. The bank cannot be debtor to two perſons for the ſame thing; and the owner of bank-money who has no receipt cannot demand payment of the bank till he buys one. In ordinary and quiet times, he can find no difficulty in getting one to buy at the market-price, which generally correſponds with the price at what he can ſell the coin or bullion it entitles him to take out of the bank.

It might be otherwiſe during a public calamity: an invaſion, for example, ſuch as that of the French in 1672. The owners of bank-money being then all eager to draw it out of the bank, in order to have it in their own keeping, the demand for receipts might raiſe their price to an exorbitant height. The holders of them might

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might form extravagant expectations, and instead of 2 or 5 *per cent.* demand half the bank-money for which credit had been given upon the deposits that the receipts had respectively been granted for. The enemy, informed of the constitution of the bank, might even buy them up in order to prevent the carrying away of the treasure. In such emergencies, the bank, it is supposed, would break through its ordinary rule of making payment only to the holders of receipts. The holders of receipts, who had no bank-money, must have received within 2 or 3 *per cent.* of the value of the deposit for which their respective receipts had been granted. The bank, therefore, it is said, would in this case make no scruple of paying, either with money or bullion, the full value of what the owners of bank-money who could get no receipts were credited for in its books; paying at the same time 2 or 3 *per cent.* to such holders of receipts as had no bank-money, that being the whole value which in this state of things could justly be supposed due to them.

Even in ordinary and quiet times it is the interest of the holders of receipts to depress the agio, in order either to buy bank-money (and consequently the bullion which their receipts would then enable them to take out of the bank) so much cheaper, or to sell their receipts to those who have bank-money, and who want to take out bullion, so much dearer; the price of a receipt being generally equal to the difference between the market-price of bank-money and that of the coin or bullion for which the receipt had been granted. It is the interest of the owners of bank-money, on the contrary, to raise the agio, in order either to sell their bank-money so much dearer, or to buy a receipt so much cheaper. To prevent the stock-jobbing tricks which those opposite interests might sometimes occasion, the bank has of late years come to a resolution to sell at all times bank-money for currency, at 5 *per cent.* agio, and to buy it again at 4 *per cent.* agio. In consequence of this resolution, the agio can never either rise above 5 or sink below 4 *per cent.* and the proportion between the market-price of the bank and that of current money is kept at all times very near to the proportion between their intrinsic values. Before this resolution was taken, the market-price of money used sometimes to rise so high as 9 *per cent.* agio, and sometimes to sink so low as par, according as opposite interests happened to influence the market.

The bank of Amsterdam professes to lend out no part of what is deposited with it, but, for every gilder for which it gives credit in its books, to keep in its repositories the value of a gilder either in money or bullion. That it keeps in its repositories all the money or bullion for which there are receipts in force, for which it is at all times liable to be called upon, and which, in reality, is continually going from it and returning to it again, cannot well be doubted. But whether it does so likewise with regard to that part of its capital for which the receipts are long ago expired, for which in ordinary and quiet times it cannot be called upon, and which in reality is very likely to remain with it for ever, or as long as the States of the United Provinces subsist, may appear perhaps more uncertain. At Amsterdam, however, no part of faith is better established, than that for every gilder circulated as bank-money there is a correspondent gilder in gold and silver to be found in the treasure of the bank. The city is guarantee that it should be so. The bank is under the direction of the four reigning burgomasters, who are changed every year. Each new set of burgomasters visits the treasure, compares it with the books, receives it upon oath, and delivers it over, with the same awful solemnity, to the set which succeeds it; and in that sober and religious country oaths are not yet disregarded. A rotation of this kind seems alone a sufficient security against any practices which cannot be avowed. Amidst all the revolutions which faction has ever occasioned in the government of Amsterdam, the prevailing party has at no time accused their predecessors of infidelity in the administration of the bank. No accusation could have affected more deeply the reputation and fortune of the disgraced party; and if such an accusation could have been supported, we may be assured that it would have been brought. In 1672, when the French king was at Utrecht, the bank of Amsterdam paid so readily as left no doubt of the fidelity with which it had observed its engagements. Some of the pieces which were then brought from its repositories appeared to have been scorched with the fire which happened in the town-house soon after the bank was established. Those pieces, therefore, must have lain there from that time.

What may be the amount of the treasure in the bank is a question which has long employed the speculations of the curious. Nothing but conjecture can be offered concerning it. It is generally reckoned, that there are about 2000 people who keep accounts with the bank; and allowing them to have, one with another, the value of 1500l. lying upon their respective accounts (a very large allowance), the whole quantity of bank-money, and consequently of treasure in the bank, will amount to 3,000,000l. or, at 11 gilders the pound Sterling, 33,000,000 of gilders; a great sum, and sufficient to carry on a very extensive circulation, but vastly below the extravagant ideas which some people have formed of this treasure.

The city of Amsterdam derives a considerable revenue from the bank. Besides what may be called the *warehouse rent* above-mentioned, each person, upon first opening an account with the bank, pays a fee of 10 gilders; and for every new account, 3 gilders 3 stivers; for every transfer, 2 stivers; and if the transfer is for less than 300 gilders, 6 stivers; in order to discourage the multiplicity of small transactions. The person who neglects to balance his accounts twice in the year forfeits 25 gilders. The person who orders a transfer for more than is upon his account, is obliged to pay 3 *per cent.* for the sum overdrawn, and his order is set aside into the bargain. The bank is supposed, too, to make a considerable profit by the sale of the foreign coin or bullion which sometimes falls to it by the expiring of receipts, and which is always kept till it can be sold with advantage. It makes a profit likewise by selling bank-money at 5 *per cent.* agio, and buying it in at 4. These different emoluments amount to a good deal more than what is necessary for paying the salaries of officers, and defraying the expence of management. What is paid for the keeping of bullion upon receipts, is alone supposed to amount to a neat annual revenue of between 150,000 and 200,000 gilders. Public utility, however, and not revenue, was the original object of

this

this inſtitution. Its object was to relieve the merchants from the inconvenience of a diſadvantageous exchange. The revenue which has ariſen from it was unforeſeen, and may be conſidered as accidental.

Bank, in ſea affairs, denotes an elevation of the ground or bottom of the ſea, ſo as ſometimes to ſurmount the ſurface of the water, or at leaſt to leave the water ſo ſhallow as uſually not to allow a veſſel to remain afloat over it.—In this ſenſe, *bank* amounts to much the ſame as flat, ſhoal, &c. There are banks of ſand, and others of ſtone, called alſo *ſhelves*, or *rocks*. In the North ſea they alſo ſpeak of banks of ice, which are large pieces of that matter floating.

BANKER, a perſon who traffics and negociates in money; who receives and remits money from place to place by commiſſion from correſpondents, or by means of bills or letters of exchange, &c.

The ancient bankers were called *argentarii*, and *nummularii*; by the Greeks, τραπεζῖται, κολλυβισαι, and αργυραμοιβοι. Their chief buſineſs was to put out the money of private perſons to intereſt; they had their boards and benches, for this purpoſe, in all the markets and public places, where they took in the money from ſome to lend it to others.

BANKING, the making of banks to oppoſe the force of the ſea, rivers, or the like, and ſecure the land from being overflowed thereby. With reſpect to the water which is to be kept out, this is called *banking*; with reſpect to the land, which is hereby to be defended, *imbanking*.

Banking is alſo applied to the keeping a bank, or the employment of a banker. Banking, in this ſenſe, ſignifies the trading in money, or remitting it from place to place, by means of bills of exchange. This anſwers to what the French call *faire la banque*. In France, every body is allowed to bank, whether merchant or not; even foreigners are indulged in this kind of traffic. In Italy, banking does not derogate from nobility, eſpecially in the republican ſtates; whence it is, that moſt of the younger ſons of great families engage in it. In reality, it was the nobility of Venice and Genoa, that, for a long time, were the chief bankers in the other countries of Europe.

BANKISH, a province of the Mogul's dominions, in the north part of the Hither India, lying ſouthweſt of the province of Caſſimere.

BANKRUPT, (*bancus ruptus*), is ſo called, becauſe, when the bank or ſtock is broken or exhauſted, the owner is ſaid to be a *bankrupt*. And this word *bankrupt* is derived from the French *banqueroute*, which ſignifies a breaking or failing in the world: *banque* in French is as much as *menſa* in Latin, and *route* is the ſame as *veſtigium*; and this term is ſaid to have been taken originally from the Roman *menſarii*, which were ſet in public places; and when a tradeſman ſlipped away, with an intention to deceive his creditors, he left only ſome *veſtigia* or ſigns of his table or ſhop behind him. But a bankrupt with us, from the ſeveral deſcriptions given of him in our ſtatute-law, may be defined "a trader, who ſecretes himſelf, or does certain other acts tending to defraud his creditors." For the better underſtanding of this article, it will be proper to conſider, 1. *Who* may become a bankrupt. 2. What *acts* make a bankrupt. 3. The *proceedings* on a commiſſion of bankruptcy: and, 4. In what manner an eſtate in goods and chattels may be *transferred* by bankruptcy.—But of theſe, the two laſt being treated under the article *Commission of Bankruptcy*, the two firſt only belong to this place.

1. A bankrupt was formerly conſidered merely in the light of a criminal or offender; and in this ſpirit we are told by Sir Edward Coke, that we have fetched as well the name, as the wickedneſs, of bankrupts from foreign nations. But at preſent the laws of bankruptcy are conſidered as laws calculated for the benefit of trade, and founded on the principles of humanity as well as juſtice; and to that end they confer ſome privileges not only on the creditors, but alſo on the bankrupt or debtor himſelf. On the creditors; by compelling the bankrupt to give up all his effects to their uſe, without any fraudulent concealment: on the debtor, by exempting him from the rigour of the general law, whereby his perſon might be confined at the diſcretion of his creditor, though in reality he has nothing to ſatisfy the debt; whereas the law of bankrupts, taking into conſideration the ſudden and unavoidable accidents to which men in trade are liable, has given them the liberty of their perſons, and ſome pecuniary emoluments, upon condition they ſurrender up their whole eſtate to be divided among their creditors.

In this reſpect our legiſlature ſeems to have attended to the example of the Roman law. We mean not the terrible law of the twelve tables, whereby the creditors might cut the debtor's body into pieces, and each of them take his proportionable ſhare: if indeed that law, *de debitore in partes ſecando*, is to be underſtood in ſo very butcherly a light; which many learned men have with reaſon doubted. Nor do we mean thoſe leſs inhuman laws (if they may be called ſo, as *their* meaning is indiſputably certain), of impriſoning the debtor's perſon in chains; ſubjecting him to ſtripes and hard labour, at the mercy of his rigid creditor; and ſometimes ſelling him, his wife, and children, to perpetual foreign ſlavery *trans Tiberim* (A): an oppreſſion which produced ſo many popular inſurrections, and ſeceſſions to the *mons ſacer*. But we mean the law of ceſſion, introduced by the Chriſtian emperors; whereby, if a debtor *ceded* or yielded up all his fortune to his creditors, he was ſecured from being dragged to a gaol, "*omni quoque corporali cruciatu ſemoto*." For, as the emperor juſtly obſerves, "*inhumanum erat ſpoliatum fortunis ſuis in ſolidum damnari*." Thus far was juſt and reaſonable: but as the departing from one extreme is apt to produce its oppoſite, we find it afterwards enacted, that if the debtor by any unforeſeen accident was reduced to low circumſtances, and would ſwear that he had not ſufficient left to pay his debts, he ſhould not be compelled to cede or give up even that which

Blackſt. Comm. II. 472. &c.

(A) In Pegu, and the adjacent countries in the Eaſt Indies, the creditor is entitled to diſpoſe of the debtor himſelf, and likewiſe of his wife and children; inſomuch, that he may even violate with impunity the chaſtity of the debtor's wife; but then, by ſo doing, the debt is underſtood to be diſcharged.

Bankrupt. which he had in his possession; a law which, under a false notion of humanity, seems to be fertile of perjury, injustice, and absurdity.

The laws of England, more wisely, have steered in the middle between both extremes: providing at once against the inhumanity of the creditor, who is not suffered to confine an honest bankrupt after his effects are delivered up; and at the same time taking care that all his just debts shall be paid, so far as the effects will extend. But still they are cautious of encouraging prodigality and extravagance by this indulgence to debtors: and therefore they allow the benefit of the laws of bankruptcy to none but actual traders; since that set of men are, generally speaking, the only persons liable to accidental losses, and to an inability of paying their debts, without any fault of their own. If persons in other situations of life run in debt without the power of payment, they must take the consequence of their own indiscretion, even though they meet with sudden accidents that may reduce their fortunes: for the law holds it to be an unjustifiable practice, for any person but a trader to encumber himself with debts of any considerable value. If a gentleman, or one in a liberal profession, at the time of contracting his debts, has a sufficient fund to pay them, the delay of payment is a species of dishonesty, and a temporary injustice to his creditor: and if, at such time, he has not sufficient fund, the dishonesty and injustice is the greater. He cannot therefore murmur, if he suffers the punishment which he has voluntarily drawn upon himself. But in mercantile transactions the case is far otherwise. Trade cannot be carried on without mutual credit on both sides; the contracting of debts is therefore here not only justifiable but necessary. And if, by accidental calamities, as by the loss of a ship in a tempest, the failure of brother-traders, or by the non-payment of persons out of trade, a merchant or trader becomes incapable of discharging his own debts, it is his misfortune and not his fault. To the misfortunes therefore of debtors, the law has given a compassionate remedy, but denied it to their faults: since, at the same time that it provides for the security of commerce, by enacting that every considerable trader may be declared a bankrupt, for the benefit of his creditors as well as himself, it has also, to discourage extravagance, declared that no one shall be capable of being made a bankrupt, but only a trader; nor capable of receiving the full benefit of the statutes, but only an industrious trader.

In the interpretation of the several statutes made concerning English bankrupts †, it hath been held, that buying only, or selling only, will not qualify a man to be a bankrupt; but it must be both buying and selling, and also getting a livelihood by it: as, by exercising the calling of a merchant, a grocer, a mercer, or, in one general word, a *chapman*, who is one that buys and sells any thing. But no handicraft occupation (where nothing is bought or sold, and therefore an extensive credit, for the stock in trade, is not necessary to be had) will make a man a regular bankrupt; as that of a husbandman, a gardener, and the like, who are paid for their work and labour. Also an innkeeper cannot, as such, be a bankrupt: for his gain or livelihood does not arise from buying and selling in the way of merchandise, but greatly from the use of his rooms and furniture, his attendance, and the like; and though he may buy corn and victuals, to sell again at a profit, yet that no more makes him a trader, than a schoolmaster or other person is, that keeps a boarding-house, and makes considerable gains by buying and selling what he spends in the house, and such a one is clearly not within the statutes. But where persons buy goods, and make them up into saleable commodities, as shoemakers, smiths, and the like; here, though part of the gain is by bodily labour, and not by buying and selling, yet they are within the statutes of bankrupts; for the labour is only in melioration of the commodity, and rendering it more fit for sale.

† 34 *Hen. VIII.* c. 4. 13 *Eliz.* c. 21 *Jac. I* c. 19. 5 *Geo. II.* c. 30.

2. To learn what the acts of bankruptcy are which render a man a bankrupt, we must consult the several statutes, and the resolutions formed by the courts thereon. Among these may therefore be reckoned, 1. Departing from the realm, whereby a man withdraws himself from the jurisdiction and coercion of the law, with an intent to defraud his creditors. 2. Departing from his own house, with an intent to secrete himself and avoid his creditors. 3. Keeping in his own house, privately (except for just and necessary cause), so as not to be seen or spoken with by his creditors; which is likewise construed to be an intention to defraud his creditors, by avoiding the process of the law. 4. Procuring or suffering himself willingly to be arrested, or outlawed, or imprisoned, without just and lawful cause; which is likewise deemed an attempt to defraud his creditors. 5. Procuring his money, goods, chattels, and effects, to be attached or sequestrated by any legal process; which is another plain and direct endeavour to disappoint his creditors of their security. 6. Making any fraudulent conveyance to a friend, or secret trustee, of his lands, tenements, goods, or chattels: which is an act of the same suspicious nature with the last. 7. Procuring any protection, not being himself privileged by parliament, in order to screen his person from arrests; which also is an endeavour to elude the justice of the law. 8. Endeavouring, or desiring, by any petition to the king, or bill exhibited in any of the king's courts against any creditors, to compel them to take less than their just debts; or to procrastinate the time of payment, originally contracted for; which are an acknowledgment of either his poverty or his knavery. 9. Lying in prison for two months, or more, upon arrest or other detention for debt, without finding bail, in order to obtain his liberty. For the inability to procure bail argues a strong deficiency in his credit, owing either to his suspected poverty, or ill character; and his neglect to do it, if able, can arise only from a fraudulent intention: in either of which cases, it is high time for his creditors to look to themselves, and compel a distribution of his effects. 10. Escaping from prison after an arrest for a just debt of 100l. or upwards. For no man would break prison, that was able and desirous to procure bail; which brings it within the reason of the last case. 11. Neglecting to make satisfaction for any just debt to the amount of 100l. within two months after service of legal process, for such debt, upon any trader having privilege of parliament.

These are the several acts of bankruptcy expressly defined by the statutes relating to this article; which being

Banks.

being so numerous, and the whole law of bankrupts being an innovation on the common law, our courts of justice have been tender of extending or multiplying acts of bankruptcy by any construction or implication. And therefore Sir John Holt held, that a man's removing his goods privately to prevent their being seized in execution, was no act of bankruptcy. For the statutes mention only fraudulent gifts to third persons, and procuring them to be seized by sham process, in order to defraud creditors: but this, though a palpable fraud, yet, falling within neither of those cases, cannot be adjudged an act of bankruptcy. So also it has been determined expressly, that a banker's stopping or refusing payment is no act of bankruptcy: for it is not within the description of any of the statutes; and there may be good reasons for his so doing, as suspicion of forgery, and the like: and if, in consequence of such refusal, he is arrested, and puts in bail, still it is no act of bankruptcy; but if he goes to prison, and lies there two months, then, and not before, is he become a bankrupt.

As to the consequences resulting from the unhappy situation of a bankrupt, see the article *Commission of Bankruptcy*.

BANKS, John, a dramatic writer, was bred to the law, and belonged to the society of Gray's Inn; but this profession not suiting his natural disposition, he quitted it for the service of the muses. Here, however, he found his rewards by no means adequate to his deserts. His emoluments at the best were precarious, and the various successes of his pieces too feelingly convinced him of the error in his choice. This, however, did not prevent him from pursuing with cheerfulness the path he had taken; his thirst of fame, and warmth of poetic enthusiasm, alleviating to his imagination many disagreeable circumstances into which indigence, the too frequent attendant on poetical pursuits, frequently threw him. His turn was entirely to tragedy; his merit in which is of a peculiar kind. For at the same time that his language must be confessed to be extremely unpoetical, and his numbers uncouth and unharmonious; nay, even his characters very far from being strongly marked or distinguished, and his episodes extremely irregular: yet it is impossible to avoid being deeply affected at the representation, and even at the reading, of his tragic pieces. This is owing in the general to a happy choice of his subjects; which are all borrowed from history, either real or romantic; and indeed the most of them from circumstances in the annals of our own country, which, not only from their being familiar to our continual recollection, but even from their having some degree of relation to ourselves, we are apt to receive with a kind of partial prepossession, and a pre-determination to be pleased. He has constantly chosen as the basis of his plays such tales as were in themselves and their well-known catastrophes most truly adapted to the purposes of the drama. He has indeed but little varied from the strictness of historical facts; yet he seems to have made it his constant rule to keep the scene perpetually alive, and never suffer his characters to droop. His verse is not poetry, but prose run mad. Yet will the false gem sometimes approach so near in glitter to the true one, at least in the eyes of all but real connoisseurs (and how small a part of an audience are to be ranked in this class it will need no ghost to inform us,) that bombast will frequently pass for the true sublime; and where it is rendered the vehicle of incidents in themselves affecting, and in which the heart is apt to interest itself, it will perhaps be found to have a stronger power on the human passions than even that property to which it is in reality no more than a bare succedaneum. And from these principles it is that we must account for Mr Banks's writings having in the general drawn more tears from, and excited more terror in, even judicious audiences, than those of much more correct and more truly poetical authors. The tragedies he has left behind him are, 1. Albion Queens. 2. Cyrus the Great. 3. Destruction of Troy. 4. Innocent Usurper. 5. Island Queens. This is only the Albion Queens altered. 6. Rival Kings. 7. Virtue Betrayed. 8. Unhappy Favourite. The Albion Queens was rejected by the managers in 1684; but was acted by Queen Anne's command in 1706, with great applause, and has been several times revived. The Unhappy Favourite continued till very lately a stock tragedy at the theatres; but gives way at present to the latter tragedies from the same story, by Jones and Brooke.—Neither the time of the birth, nor that of the death, of this author, are ascertained. His remains, however, lie interred in the church of St James's, Westminster.

Banks || Bann.

BANKS'S island, a small island in the South sea, discovered by Captain Cook in 1770, in S. Lat. 53. 32. W. Long. 186. 30. It is of a circular figure, and about 24 leagues in compass: it is sufficiently high to be seen at the distance of 12 or 15 leagues; and the land has a broken irregular surface, with the appearance of barrenness rather than fertility. It is, however, inhabited; as some straggling savages were observed upon it.

BANKSIA. See Botany *Index*.

BANN, or Ban (from the Brit. *ban*, i. e. clamour), is a proclamation or public notice; any public summons or edict, whereby a thing is commanded or forbidden. It is a word ordinary among the feudists; and there is both *banus* and *banum*, which signify two several things.—The word *banns* is particularly used in England in publishing matrimonial contracts; which is done in the church before marriage, to the end that if any persons can speak against the intention of the parties, either in respect of kindred, precontract, or for other just cause, they may take their exception in time, before the marriage is consummated; and in the canon law, Bannæ *sunt proclamationes sponsi et sponsæ in ecclesiis fieri solitæ*. But there may be a faculty or license for the marriage, and then this ceremony is omitted: and ministers are not to celebrate matrimony between any persons without a license, except the banns have been first published three several times, upon pain of suspension, &c. Can. 62.

The use of matrimonial banns is said to have been first introduced in the Gallican church, though something like it obtained even in the primitive times; and it is this that Tertullian is supposed to mean by *trinundina promulgatio*. The council of Lateran first extended, and made the usage general. By the ordinance of Blois, no person could validly contract marriage, without a preceding proclamation of three banns; nor could any person whatever be dispensed with, except

cept for the two laſt. But the French themſelves have abated much of this ſeverity; and only minors are now under an abſolute neceſſity of ſubmitting to the formality of banns. For majors, or thoſe of age, after publication of the firſt banns, the two latter are eaſily bought off.

Bann, is alſo uſed to denote proſcription or baniſhment for a crime proved; becauſe anciently publiſhed by ſound of trumpet; or, as Voſſius thinks, becauſe thoſe who did not appear at the above-mentioned ſummons, were puniſhed by proſcription. Hence, *to put a prince under the bann of the empire*, is to declare him diveſted of all his dignities. The ſentence only denotes an interdict of all intercourſe, and offices of humanity, with the offender; the form of which ſeems taken from that of the Romans, who baniſhed perſons by forbidding them the uſe of fire and water. Sometimes alſo cities are put under the imperial bann; that is, ſtripped of their rights and privileges.

Bann alſo denotes a pecuniary mulct, or penalty, laid on a delinquent for offending againſt a bann.

Bann, or Bannus, a title anciently given to the governor or viceroy of Croatia, Dalmatia, and Sclavonia.

Epiſcopal Bann (*Bannus Epiſcopalis*), a mulct paid to the biſhop by thoſe guilty of ſacrilege and other crimes.

Bann is alſo uſed for a ſolemn anathema, or excommunication attended with curſes, &c. In this ſenſe we read of *papal banns*, &c.

Bann, in *Military Affairs*, a proclamation made in the army by beat of drum, ſound of trumpet, &c. requiring the ſtrict obſervance of diſcipline, either for the declaring a new officer, or puniſhing an offender.

BANNER denotes either a ſquare flag, or the principal ſtandard belonging to a prince.

We find a multiplicity of opinions concerning the etymology of the word *banner;* ſome deriving it from the Latin *bandum*, "a band or flag;" others from the word *bann*, "to ſummons the vaſſals to appear in arms;" others again from the German *ban*, "a field or tenement," becauſe landed men alone were allowed a banner: and, finally, there are ſome who think it is a corruption of *panniere*, from *pannus*, "cloth," becauſe banners were originally made of cloth.

The Banner *of France*, was the largeſt and richeſt of all the flags borne by the ancient kings in their great military expeditions. St Martin's cap was in uſe 600 years as the banner of France; it was made of taffety, painted with the image of that ſaint, and laid one or two days on his tomb to prepare it for uſe. About the year 1100 came in a more pompous apparatus. The banner royal was faſtened to the top of a maſt, or ſome tall tree, planted on a ſcaffold, borne on a carriage drawn by oxen, covered with velvet houſings, decorated with devices or cyphers of the prince reigning. At the foot of the tree was a prieſt, who ſaid maſs early every morning. Ten knights mounted guard on the ſcaffold night and day, and as many trumpets at the foot of the tree never ceaſed flouriſhing, to animate the troops. This cumberſome machine, the mode of which was brought from Italy, continued in uſe about 130 years. Its poſt was in the centre of the army. And here it was that the chief feats were performed, to carry off and defend the royal banner; for there was no victory without it, nor was any army reputed vanquiſhed till they had loſt this banner.

BANNERETS, an ancient order of knights, or feudal lords; who, poſſeſſing ſeveral large fees, led their vaſſals to battle under their own flag or banner, when ſummoned thereto by the king. The word ſeems formed from *banner*, "a ſquare flag;" or from *band*, which anciently denoted a flag.—Bannerets are alſo called in ancient writers *milites vexilliferi*, and *vexillarii bannerarii*, *bannarii*, *banderiſii*, &c.

Anciently there were two kinds of knights, *great* and *little;* the firſt whereof were called *bannerets*, the ſecond *bachelors;* the firſt compoſed the upper, the ſecond the middle, nobility.

The banneret was a dignity allowed to march under his own flag, whereas the *bachelarius eques* followed that of another. To be qualified for a banneret, one muſt be a gentleman of family, and muſt have a power to raiſe to certain number of armed men, with eſtate enough to ſubſiſt at leaſt 28 or 30 men. This muſt have been very conſiderable in thoſe days; becauſe each man, beſides his ſervant, had two horſemen to wait on him armed, the one with a croſs-bow, the other with a bow and hatchet. As he was not allowed to be a baron who had not above 13 knights fees, ſo he was not admitted to be a banneret if he had leſs than 10.

Banneret, according to Spelman, was a middle order between a baron and a ſimple knight; called ſometimes alſo *vexillarius minor*, to diſtinguiſh him from the greater, that is, from the baron, to whom alone properly belonged the *jus vexilli*, or privilege of the ſquare flag. Hence the banneret was alſo called *bannerettus, quaſi baro minor;* a word frequently uſed by Engliſh writers in the ſame ſenſe as banneret was by the French, though neither of them occur before the time of Edward II.

Some will have bannerets to have originally been perſons who had ſome portion of a barony aſſigned them; and enjoyed it under the title of *baro proximus*, and that with the ſame prerogatives as the baron himſelf. Some, again, find the origin of bannerets in France, others in Brittany, others in England. Theſe laſt attribute the inſtitution of bannerets to Conan, lieutenant of Maximus, who commanded the Roman legions in England under the empire of Gratian in 383. This general, ſay they, revolting, divided England into 40 cantons, and in theſe cantons diſtributed 40 knights; to whom he gave a power of aſſembling, on occaſion, under their ſeveral banners, as many of the effective men as were found in their reſpective diſtricts: whence they are called *bannerets*. However this be, it appears from Froiſſart, &c. that anciently ſuch of the military men as were rich enough to raiſe and ſubſiſt a company of armed men, and had a right to do ſo, were called *bannerets*. Not, however, that theſe qualifications rendered them knights, but only bannerets; the appellation of *knight* being only added thereto, becauſe they were ſimple knights before.

Bannerets were ſecond to none but knights of the garter. They were reputed the next degree below the nobility; and were allowed to bear arms with ſupporters, which none elſe may under the degree of a baron. In France, it is ſaid, the dignity was hereditary; but in England it died with the perſon that gained

gained it. The order dwindled on the inftitution of baronets by King James I. and at length became extinct. The laft perfon created banneret was Sir John Smith, made fo after Edghill fight, for refcuing the ftandard of King Charles I.

The form of the banneret's creation was this. On a day of battle, the candidate prefented his flag to the king or general; who, cutting off the train or fkirt thereof, and making it a fquare, returned it again, the proper banner of bannerets; who are hence fometimes called *knights of the fquare flag*. There feem to have been bannerets created either in a different manner, or by others than the fovereign; fince King James, in the patents of baronets, gives them precedence to all knights bannerets, except fuch as are created by the king himfelf in the field; which implies, either that there are fome of this order created out of the field, or by inferior perfons.

Banneret is alfo the name of an officer or magiftrate of Rome towards the clofe of the 14th century. —The people of that city, and throughout the territory of the church, during the difputes of the antipopes, had formed a kind of republican government; where the whole power was lodged in the hands of a magiftrate called *fenator*, and twelve heads of quarters called *bannerets*, by reafon of the banners which each raifed in his diftrict.

BANNOCK, a kind of oat-cake, baked in the embers, or on a ftone placed before the fire. It is common in the northern parts of this kingdom.

BANNUM, in *Law*, fignifies the utmoft bounds of a manor or town.

BANQUET, a feaft or entertainment where people regale themfelves with pleafant foods or fruits.

Banquet, in the *Manege*, that fmall part of the branch of a bridle that is under the eye; which being rounded like a fmall rod, gathers and joins the extremities of the bit to the branch, in fuch a manner that the banquet is not feen, but covered by the cope, or that part of the bit that is next the branch.

Banquet-Line, an imaginary line drawn, in making a bit, along the banquet, and prolonged up or down, to adjuft the defigned force or weaknefs of the branch, in order to make it ftiff or eafy.

Banquet, or *Banquette*, in *Fortification*, a little foot-bank, or elevation of earth, forming a path which runs along the infide of a parapet, upon which the mufketeers get up, in order to difcover the counterfcarp, or to fire on the enemy, in the moat or in the covert-way.

BANQUETING room or house. See Saloon. The ancient Romans fupped in the atrium, or veftibule, of their houfes; but, in after-times, magnificent faloons, or banqueting-rooms, were built, for the more commodious and fplendid entertainment of their guefts. Lucullus had feveral of thefe, each diftinguifhed by the name of fome god; and there was a particular rate of expence appropriated to each. Plutarch relates with what magnificence he entertained Cicero and Pompey, who went with defign to furprife him, by only telling a flave who waited, that the cloth fhould be laid in the Apollo. The emperor Claudius, among others, had a fplendid banqueting-room named *Mercury*. But every thing of this kind was outdone by the luftre of that celebrated banqueting-houfe of Nero, called *domus aurea*; which, by the circular motion of its partitions and ceilings, imitated the revolution of the heavens, and reprefented the different feafons of the year, which changed at every fervice, and fhowered down flowers, effences, and perfumes, on the guefts.

BANSTICKLE. See Gasterosteus, Ichthyology *Index*.

BANTAM, a town of the ifland of Java, in the Eaft Indies, fituated in E. Long. 105. 16. S. Lat. 6. 20. It is the capital of a kingdom of the fame name, with a harbour and caftle; but the harbour is now fo choked up that it is inacceffible to veffels of any great burden. It is divided into two towns feparated by a river, and one of them inhabited by the Chinefe. Bantam once enjoyed a flourifhing trade. It was a great mart for pepper and other fpices; but this trade, as well as the power of its fovereign, had fallen to decay. For its hiftory, &c. fee Java.

Bantam-work, a kind of painted or carved work, refembling that of Japan, only more gaudy.

There are two forts of Bantam, as well as of Japan work. As, in the latter, fome are flat, lying even with the black, and others high and emboffed; fo, in Bantam-work, fome are flat and others in-cut, or carved into the wood, as we find in many large fcreens: with this difference, that the Japan artifts work chiefly in gold and other metals; and thofe of Bantam generally in colours, with a fmall fprinkling of gold here and there: for the flat Bantam-work is done in colours, mixed with gum-water, proper for the thing defigned to be imitated. For the carved, or in-cut kind, the method of performing it is thus defcribed by an ingenious artift: 1. The wood is to be primed with whiting and fize, fo often till the primer lie near a quarter of an inch thick; then it is to be water-plained, *i. e.* rubbed with a fine wet cloth, and, fome time after, rubbed very fmooth, the blacks laid on, varnifhed up with a good body, and polifhed well, though with a gentle hand. This done, the defign is to be traced out with vermilion and gum-water, exactly in the manner wherein it is intended to be cut; the figures, trees, buildings, &c. in their due proportion: then the graver is applied, with other tools, of proper fhapes, differing according to the workman's fancy: with thefe he cuts deep or fhallow, as is found convenient, but never deeper than the whiting lies, the wood being never to feel the edge of the inftrument. Lines, or parts of the black, are ftill to be left for the draperies, and other outlines, and for the diftinction of one thing from another; the rule being to cut where the white is, and leave the black untouched. The carving being finifhed, then take to the pencil, with which the colours are laid into the cut-work: after this, the gold is to be laid in thofe places which the defign requires; for which purpofe, a ftrong thick gum-arabic water is taken and laid with a pencil on the work; and, while this remains wet, leaf-gold is cut with a fharp fmooth edged knife, in little pieces, fhaped to the bignefs and figure of the places where they are to be laid. Thefe being taken up with a little cotton, they daub them with the fame clofe to the gum-water, which affords a rich luftre. The work thus finifhed, they clear up the black with oil, taking care not to touch the colours. The European workmen ordinarily ufe brafs-duft, which is lefs bright and beautiful.

BANTRY,

Bantry || Baptism.

BANTRY, a town of Ireland, in the county of Cork, and province of Munster. It is seated on a bay of the same name, in W. Long. 9. 15. N. Lat. 51. 30.

BAOBAB, the name given by Prosper Alpinus to the African calabash-tree, since called ADANSONIA. See BOTANY *Index*.

BAPTISM, in matters of religion, the ceremony of washing; or a sacrament, by which a person is initiated into the Christian church.—The word is formed from the Greek βαπτιζω, of βαπτω *to dip* or *wash*. Baptism is known, in ecclesiastical writers, by divers other names and titles. Sometimes it is called *palingenesia*, or *laver of regeneration*; sometimes *salus*, or *life and salvation*; sometimes σφραγις, *signaculum Domini*, and *signaculum fidei*, or *the seal of faith*; sometimes absolutely *mysterium*, and *sacramentum*; sometimes *the sacrament of faith*; sometimes *viaticum*, from its being administered to departing persons; sometimes *sacerdotium laici*, or *the lay priesthood*, because allowed, in cases of necessity, to be conferred by laymen: sometimes it is called the *great circumcision*, because it was imagined to succeed in the room of circumcision, and to be a seal of the Christian covenant, as that was the seal of the covenant made with Abraham: so, in regard that baptism had Christ for its author, and not man, it was anciently known by the name of Δωρον and χαρισμα Κυριε, *the gift of the Lord*: sometimes it was simply called δωρον, without any other addition, by way of eminence, because it was both a gratuitous and singular gift of Christ: in reference to the making men complete members of Christ's body, the church, it had the name of Τελειωσις, and Τελειη, the *consecration*, and *consummation*; because it gave men the perfection of Christians, and a right to partake of the Το Τελιον, which was *the Lord's Supper*: it had also the name of μυησις and μυσαγωγια, the *initiation*, because it was the admittance of men to all the sacred rites and mysteries of the Christian religion.

Various names given to baptism.

Bingham's Orig. Eccles.

Its origin, &c.

Baptism has been supposed by many learned authors to have had its origin from the Jewish church, in which, as they maintain, it was the practice long before Christ's time, to baptize proselytes or converts to their faith, as part of the ceremony of their admission; a practice which, according to some, obtains among them to this day; a person turning Jew, is first circumcised, and, when healed, is bathed, or baptized in water, in presence of their rabbins; after which he is reputed a good Jew. Others, however, insist that the Jewish proselyte baptism is not by far so ancient, and that John the Baptist was the first administrator of baptism among the Jews. Of this opinion were Deylingius, J. G. Carpzovius, Boernerus, Wernsdorfius, Zeltnerus, Owen, Knatchbull, Jennings, Gill, and others.

Grotius is of opinion, that the rite of baptism had its original from the time of the deluge; immediately after which, he thinks, it was instituted in memory of the world having been purged by water. Some learned men think it was added to circumcision, soon after the Samaritan schism, as a mark of distinction to the orthodox Jews. Spencer, who is fond of deriving the rites of the Jewish religion from the ceremonies of the Pagans, lays it down as a probable supposition, that the Jews received the baptism of proselytes from the neighbouring nations, who were wont to prepare candidates for the more sacred functions of their religion, by a solemn ablution; that by this affinity of sacred rites, they might draw the Gentiles to embrace their religion, and that the proselytes (in gaining of whom they were extremely diligent (might the more easily comply with the transition from Gentilism to Judaism. In confirmation of this opinion, he observes, first, that there is no divine precept for the baptism of proselytes, God having enjoined only the rite of circumcision for the admission of strangers into the Jewish religion. Secondly, that, among foreign nations, the Egyptians, Persians, Greeks, Romans, and others, it was customary that those who were to be initiated into their mysteries, or sacred rites, should be first purified by dipping their whole body in water. That learned writer adds, as a farther confirmation of his opinion, that the cup of blessing likewise, added to the paschal supper, seems plainly to have been derived from a pagan original: for the Greeks, at their feasts, had one cup, called ποτηριον αγαθε δαιμονος, *the cup of the good dæmon or god*, which they drank at the conclusion of their entertainment, when the table was removed. Since then, a rite of Gentile origin was added to one of the Jewish sacraments, viz. the passover, there can be no absurdity in supposing, that baptism, which was added to the other sacrament, namely circumcision, might be derived from the same source. In the last place, he observes, that Christ, in the institution of his sacraments, paid a peculiar regard to those rites which were borrowed from the Gentiles: for rejecting circumcision and the paschal supper, he adopted into his religion baptism and the sacred cup; thus preparing the way for the conversion and reception of the Gentiles into his church.

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The design of the Jewish baptism, if baptism be practised by them, is supposed to be, to import a regeneration, whereby the proselyte is rendered a new man, and of a slave becomes free. The effect of it is, to cancel all former relations; so that those who were before akin to the person, after the ceremony ceased to be so. It is to this ceremony Christ is supposed to have alluded, in his expression to Nicodemus, that it was necessary that he should be born again, in order to become his disciple.—The necessity of baptism to salvation, is grounded on those two sayings of our Saviour: *He that believeth, and is baptized, shall be saved*; and, *Except a man be born of water and of the Spirit, he cannot enter into the kingdom of God*. The ancients did not generally think the mere want of baptism, where the procuring it was impracticable, excluded men absolutely from the hopes of eternal salvation. Some few of them, indeed, are pretty severe upon infants dying without baptism; and some others seem also, in general terms, to deny eternal life to adult persons dying without it: but when they interpret themselves, and speak more distinctly, they make some allowances, and except several cases, in which the want of baptism may be supplied by other means. Such are, martyrdom, which commonly goes by the name of *second baptism in men's own blood*, in the writings of the ancients; because of the power and efficacy it was thought to have to save men by the invisible baptism of the Spirit, without the external element of water. Faith, and repentance, were also esteemed a supplement to the want of baptism, in such catechumens as died while they were piously preparing themselves for baptism. Constantly

Opinions concerning the effects of baptism.

communicating

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communicating with the church, was thought to supply the want of baptism, in persons who had been admitted to communion, on a presumption of their being duly baptized, though the contrary afterwards appeared. For infants dying without baptism, the case was thought more dangerous; as here, no personal faith, repentance, or the like, could be pleaded, to supply the defect, and wash away original sin: on this account, they who spoke most favourably of them, as Greg. Nazianzen, and Severus bishop of Antioch, only assigned them a middle state, neither in heaven nor hell. But the Latins, as St Augustin, Fulgentius, Marius Mercator, &c. who never received the opinion of a middle state, concluded, as they could not be received into heaven, they must go to hell. Pelagius, and his followers, who denied original sin, asserted, that they might be admitted to eternal life and salvation, though not to the kingdom of heaven; between which they distinguished. Where the fault was not on the side of the child, nor his parents, but of the minister, or where any unavoidable accident rendered baptism absolutely impossible, Hincmar, and others, make an exception, in holding the child saved without baptism.

Of the time, place, and subjects of baptism.

The receiving baptism is not limited to any time, or age of life. Some contend for its being administered like circumcision, precisely on the eighth day, as Greg. Nazianzen; and others would have it deferred till the child is three years of age, and able to hear the mystic words, and make answer thereto, though he do not understand them. In the canon law we find divers injunctions against deferring the baptism of infants beyond the 37th day, 30th day, and the 9th day; some of them under pecuniary forfeitures.

Salmasius, and Suicerus from him, deliver it as authentic history, that for the two first ages, no one received baptism, who was not first instructed in the faith and doctrine of Christ, so as to be able to answer for himself, that he believed; because of those words, *He that believeth, and is baptized;* which, in effect, is to say, that no infant, for the first two ages, was ever admitted to Christian baptism. But, afterwards, they own, that pædo-baptism came in, upon the opinion that baptism was necessary to salvation. But Vossius, Dr Forbes, Dr Hammond, Mr Walker, and especially Mr Wall, who has exactly considered the testimony and authority of almost every ancient writer that has said any thing upon this subject, endeavour to evince, that infants were baptized even in the apostolical age. It is certain, Tertullian pleads strongly against giving baptism to infants; which shows, at least, that there was some such practice in his age, though he disapproved of it. It is certain, the ordinary subjects of this sacrament, in the first ages, were converts from Judaism and Gentilism, who, before they could be admitted to baptism, were obliged to spend some time in the state of catechumens, to qualify them to make their professions of faith, and a Christian life, in their own persons: for, without such personal professions, there was ordinarily no admission of them to the privilege of baptism. Those baptized in their sick-beds were called *clinici;* and were held in some reproach, as not being reputed true Christians. Hence several censures, in councils and ecclesiastical writers, of clinic baptism. This clinic baptism was not sufficient to qualify the person, in case of recovery, for ordination. Some had their baptism put off by way of punishment, when they fell into gross and scandalous crimes, which were to be expiated by a longer course of discipline and repentance. This was sometimes 5, 10, 20 years, or more; even all their lives to the hour of death, when their crimes were very flagrant.

In the earliest ages of the church, there was no stated time or place for the reception of baptism. Afterwards Easter, Whitsuntide, and Epiphany, became solemn seasons, out of which baptism was not administered, except in cases of necessity. The catechumens who were to receive it at these times, were called *competentes:* and to these it is that St Cyril addresses his catecheses. In the apostolical age, and some time after, before churches and baptisteries were generally erected, they baptized in any place where they had convenience; as John baptized in Jordan, and Philip baptized the eunuch in the wilderness, and Paul the sailor in his own house. But in after ages, baptisteries were built adjoining to the church; and then rules were made, that baptism should ordinarily be administered nowhere but in these buildings. Justinian, in one of his novels, refers to ancient laws, appointing that none of the sacred mysteries of the church should be celebrated in private houses. Men might have private oratories for prayer in their own houses; but they were not to administer baptism or the eucharist in them, unless by a particular license from the bishop of the place. Such baptisms are frequently condemned in the ancient councils, under the name παραβαπτισματα, *baptisms in private conventicles.*

Ancient ceremonies.

As to the attendant ceremonies and manner of baptism in the ancient church: The person to be baptized, if an adult, was first examined by the bishop or officiating priest, who put some questions to him; as, first, Whether he abjured the devil and all his works; secondly, Whether he gave a firm assent to all the articles of the Christian faith: to both which he answered in the affirmative. If the person to be baptized was an infant, these interrogatories were answered by his *sponsores*, or godfathers. Whether the use of sponsors was as old as the apostles days, is uncertain: perhaps it was not, since Justin Martyr, speaking of the method and form of baptism, says not a word of them.—After the questions and answers, followed exorcism; the manner and end of which was this: The minister laid his hands on the person's head, and breathed in his face, implying thereby the driving away or expelling of the devil from him, and preparing him for baptism, by which the good and holy spirit was to be conferred upon him.—After exorcism, followed baptism itself: and first the minister, by prayer, consecrated the water for that use. Tertullian says, "any waters may be applied to that use: but then God must be first invocated; and then the Holy Ghost presently comes down from heaven, and moves upon them, and sanctifies them." The waters being consecrated, the person was baptized "in the name of the Father, and of the Son, and of the Holy Ghost;" by which, "dedication of him to the blessed Trinity, the person (says Clemens Alexandrinus) is delivered from the corrupt trinity, the devil, the world, and the flesh." In performing the ceremony of baptism, the usual custom (except in clinical cases, or

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or where there was scarcity of water), was to immerse and dip the whole body. Thus St Barnabas, describing a baptized person, says, "We go down into the water full of sin and filth, but we ascend bearing fruit in our hearts." And this practice of immersing the whole body was so general, that we find no exceptions made in respect either to the tenderness of infants, or the bashfulness of the other sex, unless in case of sickness or other disability. But to prevent any indecency, men and women were baptized apart. To which end, either the baptisteries were divided into two apartments, one for the men, the other for the women, as Bingham has observed; or the men were baptized at one time and the women at another, as is shown by Vossius, from the *Ordo Romanus*, Gregory's *Sacramentarium*, &c. Add, that there was anciently an order of deaconesses, one part of whose business was to assist at the baptism of women. The precautions, however, rather indicate a scrupulous attention to delicacy, than imply any indecency in the circumstance of immersion itself. From the candidates being immersed, there is at least no reason to infer that they were naked: The present Baptists never baptize naked, though they always immerse. After immersion, followed the unction; by which (says St Cyril) was signified that they were now cut off from the wild olive, and were ingrafted into Christ, the true olive tree; or else to show that they were now to be champions for the gospel, and were anointed thereto, as the old athletæ were against their solemn games. With this anointing was joined the sign of the cross, made upon the forehead of the person baptized; which being done, he had a white garment given him, to denote his being washed from the defilements of sin, or in allusion to that of the apostle, "As many as are baptized in Christ have put on Christ." From this custom the feast of Pentecost, which was one of the annual seasons of baptism, came to be called *Whitsunday*, i. e. *White-sunday*. This garment was afterwards laid up in the church, that it might be an evidence against such persons as violated or denied that faith which they had owned in baptism.—When the baptism was performed, the person baptized, according to Justin Martyr, "was received into the number of the faithful, who then sent up their public prayers to God, for all men, for themselves, and for those who had been baptized."

The ordinary ministers, who had the right of administering this sacrament, that is, of applying the water to the body, and pronouncing the formula, were presbyters or bishops; though on extraordinary occasions laymen were admitted to perform the same.

Modern forms; in the church of Rome.

As to the present form of administering baptism, the church of Rome uses the following. When a child is to be baptized, the persons who bring it wait for the priest at the door of the church, who comes thither in his surplice and purple stole, attended by his clerks. He begins with questioning the godfathers, whether they promise, in the child's name, to live and die in the true catholic and apostolic faith, and what name they would give the child. Then follows an exhortation to the sponsors; after which the priest, calling the child by its name, asks it as follows: *What dost thou demand of the church?* The godfather answers, *Eternal life.* The priest goes on: *If you are desirous of obtaining eternal life, keep God's commandments, thou shalt love the Lord thy God*, &c. After which he breathes three times in the child's face, saying, *Come out of this child, thou evil spirit, and make room for the Holy Ghost.* This said, he makes the sign of the cross on the child's forehead and breast, saying, *Receive the sign of the cross on thy forehead, and in thy heart.* Then taking off his cap, he repeats a short prayer; and laying his hand gently on the child's head, repeats a second prayer: which ended, he blesses some salt; and putting a little of it into the child's mouth, pronounces these words, *Receive the salt of wisdom.* All this is performed at the church-door. The priest, with the godfathers and god-mothers, coming into the church, and advancing towards the font, repeat the apostles-creed and the Lord's-prayer. Being come to the font, the priest exorcises the evil spirit again; and taking a little of his own spittle, with the thumb of his right-hand, rubs it on the child's ears and nostrils, repeating, as he touches the right ear, the same word (*Ephatha, be thou opened*) which our Saviour made use of to the man born deaf and dumb. Lastly, they pull off its swaddling-clothes, or strip it below the shoulders, during which the priest prepares the oils, &c. The sponsors then hold the child directly over the font, observing to turn it due east and west: whereupon the priest asks the child, *Whether he renounces the devil and all his works?* and the godfather having answered in the affirmative, the priest anoints the child between the shoulders in the form of a cross. Then taking some of the consecrated water, he pours part of it thrice on the child's head, at each perfusion calling on one of the Persons of the Holy Trinity. The priest concludes the ceremony of baptism with an exhortation.—The Romish church allows midwives, in cases of danger, to baptize a child before it comes entirely out of its mother's womb: where it is to be observed, that some part of the body of the child must appear before it can be baptized, and that it is baptized on the part which first appears: if it be the head, it is not necessary to rebaptize the child; but if only a foot or hand appears, it is necessary to repeat baptism. A stillborn child thus baptized may be buried in consecrated ground.

In the Greek church.

The Greek church differs from the Romish, as to the rite of baptism, chiefly in performing it by immersion, or plunging the infant all over in the water.

English form in the liturgy of King Edward.

The forms of administering baptism among us being too well known to require a particular description, we shall only mention one or two of the more material differences between the form, as it stood in the first liturgy of King Edward, and that in the English Common Prayer Book at present. First, the form of consecrating the water did not make a part of the office, in King Edward's liturgy, as it does in the present, because the water in the font was changed, and consecrated, but once a month. The form likewise itself was something different from that now used; and was introduced with a short prayer, that *Jesus Christ, upon whom (when he was baptized) the Holy Ghost came down in the likeness of a dove, would send down the same Holy Spirit, to sanctify the fountain of baptism;* which prayer was afterwards left out, at the second review.—By King Edward's first book, the minister is to dip the child in the water thrice; first, dipping the right-side; secondly, the left; the third time, dipping the face toward the foot. This trine immersion was a very ancient

Baptism. cient practice in the Christian church, and used in honour of the Holy Trinity; though some later writers say, it was done to represent the death, burial, and resurrection, of Christ, together with his three days continuance in the grave. Afterwards, the Arians making an ill use of it, by persuading the people that it was used to denote that the three Persons in the Trinity were three distinct substances, the orthodox left it off, and used only one single immersion.

By the first common-prayer of King Edward, after the child was baptized, the godfathers and godmothers were to lay their hands upon it, and the minister was to put on him the white vestment commonly called the *chrysome*, and to say, "Take this white vesture, as a token of the innocency, which, by God's grace, in this holy sacrament of baptism, is given unto thee; and for a sign, whereby thou art admonished, so long as thou livest, to give thyself to innocence of living, that after this transitory life thou mayest be partaker of the life everlasting. Amen." As soon as he had pronounced these words, he was to anoint the infant on the head, saying, "Almighty God, the father of our Lord Jesus Christ, who hath regenerated thee by water and the Holy Ghost, and hath given unto thee remission of all thy sins; may he vouchsafe to anoint thee with the unction of his Holy Spirit, and bring thee to the inheritance of everlasting life. Amen." This was manifestly done in imitation of the practice of the primitive church.

The custom of sprinkling children, instead of dipping them in the font, which at first was allowed in case of the weakness or sickness of the infant, has so far prevailed, that immersion is at length quite excluded. What principally tended to confirm the practice of affusion or sprinkling, was, that several of our Protestant divines, flying into Germany and Switzerland during the bloody reign of Queen Mary, and returning home when Queen Elizabeth came to the crown, brought back with them a great zeal for the Protestant churches beyond sea, where they had been sheltered and received; and having observed, that at Geneva and some other places, baptism was administered by sprinkling, they thought they could not do the church of England a greater piece of service than by introducing a practice dictated by so great an oracle as Calvin. This, together with the coldness of our northern climate, was what contributed to banish entirely the practice of dipping infants in the font.

Notions concerning the effects of baptism.

Many different notions have been entertained concerning the effects of baptism, which it would be endless to enumerate.—The Remonstrants and Socinians reduce baptism to a mere sign of divine grace. The Romanists, on the contrary, exalt its power; holding, that all sin is entirely taken away by it; that it absolutely confers the grace of justification, and consequently grace *ex opere operato*. Some also speak of an indelible character impressed on the soul by it, called *character dominicus*, and *character regius*: but this is held, by others, a mere chimera; for that the spiritual character, conferred in regeneration, may easily be effaced by mortal sins. Dodwell maintained, that it is by baptism the soul is made immortal; so that those who die without it will not rise again. It must be added, he restrains this effect to episcopal baptism alone. From the effects ordinarily ascribed to baptism, even by ancient writers, it should seem, that the ceremony is as much of heathen as Jewish origin; since Christians do not restrain the use of it, like the Jews, to the admission of new members into the church, but hold, with the heathens, a virtue in it for remitting and washing away sins. The Bramins are still said to baptize with this latter view, at certain seasons, in the river Ganges; to the waters whereof they have annexed a cleansing or sanctifying quality; and hence it is that they flock from all parts, even of Tartary, driven by the expectation of their being eased of their load of sins. But, in this point, many Christians seem to have gone beyond the folly of the heathens. It was only the smaller sins of infirmity which these latter held to be expiable by washing; for crimes of a blacker dye, they allowed no water could efface them, no purgation could discharge them. The Christian doctrine of a total remission of sins by baptism could not fail, therefore, to scandalize many among the heathens, and furnished Julian an occasion of satirising Christianity itself: "Whoever (says he) is guilty of rapes, murders, sacrilege, or any abominable crime, let him be washed with water, and he will become pure and holy."

In the ancient church, baptism was frequently conferred on Jews by violence: but the church itself never seems to have allowed of force on this occasion. By a canon of the fourth council of Toledo, it is expressly forbid to baptize any against their wills. That which looks most like force in this case, allowed by law, were two orders of Justinian; one of which appoints the heathens, and the other Samaritans, to be baptized, with their wives and children and servants, under pain of confiscation. By the ancient laws, baptism was not to be conferred on image-makers, stage-players, gladiators, *aurigæ* or public drivers, magicians, or even strolling beggars, till they quitted such professions. Slaves were not allowed the privilege of baptism without the testimony and consent of their masters; excepting the slaves of Jews, Heathens, and heretics; who were not only admitted to baptism, but, in consequence thereof, had their freedom. Vossius has a learned and elaborate work *De Baptismo*, wherein he accurately discusses all the questions concerning baptism according to the doctrine of the ancients.

Bingham. Orig. Eccl. l. 11. c. 5. § 4. l. 8. c. 11. § 17.

BAPTISM *by Fire*, spoken of by St John the Baptist, has occasioned much conjecture. The generality of the fathers held, that believers, before they enter paradise, are to pass through a certain fire, which is to purify them from all pollutions remaining on them unexpiated. Others, with St Basil, understand it of the fire of hell; others, of that of tribulation and temptation. Others, with St Chrysostom, will have it denote an abundance of graces. Others suppose it to mean the descent of the Holy Ghost on the apostles, in form of fiery tongues. Lastly, others maintain, that the word *fire* here is an interpolation; and that we are only to read the text, *He that shall come after me will baptize you with the Holy Ghost.* In reality, it is not found in divers manuscript copies of St Matthew.

The ancient Selucians and Hermians, understanding the passage literally, maintained, that material fire was necessary in the administration of baptism. But we do not find how or to what part of the body they applied it, or whether they were satisfied with obliging the

the person baptized to pass through the fire. Valentinus rebaptized all who had received water-baptism, and conferred on them the baptism of fire.

Bis docuit tingi, traductoque corpore flamma.
TERTULL. Carm. contr. Marc. l. 1.

Heracleon, cited by Clemens Alexandrinus, says, that some applied a red-hot iron to the ears of the person baptized, as if to impress some mark upon him.

BAPTISM of the Dead, a custom which anciently prevailed among some people in Africa, of giving baptism to the dead. The third council of Carthage speaks of it as a thing that ignorant Christians were fond of. Gregory Nazianzen also takes notice of the same superstitious opinion prevailing among some who delayed to be baptized. In his address to this kind of men, he asks, whether they stayed to be baptized after death? Philastrius also notes it as the general error of the Montanists or Cataphrygians, that they baptized men after death. The practice seems to be grounded on a vain opinion, that, when men had neglected to receive baptism in their life-time, some compensation might be made for this default by receiving it after death.

Baptism of the Dead was also a sort of vicarious baptism, formerly in use, when a person dying without baptism, another was baptized in his stead.

St Chrysostom tells us, this was practised among the Marcionites with a great deal of ridiculous ceremony; which he thus describes: After any catechumen was dead, they hid a living man under the bed of the deceased; then coming to the dead man, they asked him, whether he would receive baptism; and he making no answer, the other answered for him, and said, he would be baptized in his stead: and so they baptized the living for the dead.

Epiphanius assures us, the like was also practised among the Corinthians. This practice they pretended to found on the Apostle's authority; alleging that text of St Paul for it, *If the dead rise not at all, what shall they do who are baptized for the dead?* A text which has given occasion to a great variety of different systems and explications. Vossius enumerates no less than nine different opinions among learned divines concerning the sense of the phrase, *being baptized for the dead.*

St Ambrose and Walafred Strabo seem clearly of opinion, that the apostle had respect to such a custom then in being; and several moderns have given into the same opinion, as Baronius, Jos. Scaliger, Justellus, and Grotius.

Several among the Roman Catholics, as Bellarmin, Salmeron, Menochius, and a number of schoolmen, understand it of the baptism of tears, and penance, and prayers, which the living undergo for the dead; and thus allege it as a proof of the belief of purgatory in St Paul's days.

Hypothetical BAPTISM, that formerly administered in certain doubtful cases, with this formula: *If thou art baptized, I do not rebaptize; if thou art not, I baptize thee in the name of the Father*, &c. This sort of baptism, enjoined by some ancient constitutions of the English church, is now fallen into disuse.

Solemn BAPTISM, that conferred at stated seasons; such, in the ancient church, were the *Paschal baptism*, and that at Whitsuntide. This is sometimes also called *general baptism.*

Lay BAPTISM, we find to have been permitted by both the Common-prayer Books of King Edward and that of Queen Elizabeth, when an infant is in immediate danger of death, and a lawful minister cannot be had. This was founded upon the mistaken notion of the impossibility of salvation without the sacrament of baptism: but afterwards, when they came to have clearer notions of the sacraments, it was unanimously resolved in a convocation, held in the year 1575, that even private baptism, in a case of necessity, was only to be administered by a lawful minister.

BAPTISM is also applied, abusively, to certain ceremonics used in giving names to things inanimate.

The ancients knew nothing of the custom of giving baptism to inanimate things, as bells, ships, and the like, by a superstitious consecration of them. The first notice we have of this is in the Capitulars of Charles the Great, where it is only mentioned to be censured: but, afterwards, it crept into the Roman offices by degrees. Baronius carries its antiquity no higher than the year 968, when the greatest bell of the church of Lateran was christened by Pope John III. At last it grew to that superstitious height, as to be thought proper to be complained of in the *Centum Gravamina* of the German nation, drawn up in the public diet of the empire held at Nuremberg *anno* 1581; where (after having described the ceremony of baptizing a bell, with godfathers, who make responses as in baptism, and give it a name, and clothe it with a new garment as Christians were used to be clothed, and all this to make it capable of driving away tempests and devils) they conclude against it, as not only a superstitious practice, but contrary to the Christian religion, and a mere seduction of the simple people.

BAPTISM, in the sea language, a ceremony in long voyages on board merchant ships, practised both on persons and vessels who pass the tropic or line for the first time. The baptizing the vessels is simple, and consists only in washing them throughout with sea-water; that of the passengers is more mysterious. The oldest of the crew, that has past the tropic or line, comes with his face blacked, a grotesque cap on his head, and some sea-book in his hand, followed by the rest of the seamen dressed like himself, each having some kitchen utensil in his hand, with drums beating; he places himself on a seat on the deck, at the foot of the mainmast. At the tribunal of this mock magistrate, each passenger not yet initiated, swears he will take care the same ceremony be observed, whenever he is in the like circumstances: Then, by giving a little money by way of gratification, he is discharged with a little sprinkling of water; otherwise he is heartily drenched with streams of water poured upon him; and the ship boys are enclosed in a cage, and ducked at discretion.—The seamen, on the baptizing a ship, pretend to a right of cutting off the beak-head unless redeemed by the captain.

BAPTISMAL, something belonging to baptism; thus we say baptismal vow, presents, &c.

BAPTISMAL Vow or *Covenant*, a profession of obedience to the laws of Christ, which persons in the ancient church made before baptism. It was an indispensable

pensable part of the obligation on catechumens, before they were admitted to the ceremony of regeneration. It was made by turning to the east; for what mystical reasons, is not well agreed on.

Baptismal Presents are in use in Germany, made by the sponsors to the infant, consisting of money, plate, or even sometimes fiefs of lands; which by the laws of the country are to be kept for the child till of age, the parents having only the trust, not the right, of disposing of them. An anonymous author has published a discourse express on this occasion, entitled, *De pecunia lustrica.*

BAPTIST, John Monnoyer, a painter of flowers and fruit, was born at Lisle in 1635, and educated at Antwerp, where he perfected himself in the knowledge of his art, and in his first years was intended for a painter of history: but having soon observed that his genius more strongly inclined him to the painting of flowers, he applied his talents to those subjects, and in that style became one of the greatest masters. His pictures are not so exquisitely finished as those of Van Huysum, but his composition and colouring are in a bolder style. His flowers have generally a remarkable freedom and looseness, as well in the disposition as in the penciling; together with a tone of colouring that is lively, admirable, and nature itself. The disposition of his objects is surprisingly elegant and beautiful; and in that respect his compositions are easily known, and as easily distinguished from the performances of others. He died in 1699.—He left a son, Anthony, who painted flowers in the same style and manner, and had great merit.

BAPTISTS, in *Ecclesiastical History*, (from βαπτιζω, *I baptize*); a denomination of Christians, distinguished from other Christians by their particular opinions respecting the mode and the subjects of baptism.

Instead of administering the ordinance by sprinkling or pouring water, they maintain that it ought to be administered only by immersion. Such, they insist, is the meaning of the word βαπτιζω; so that a command to baptize is a command to immerse. Thus it was understood by those who first administered it. John the Baptist, and the apostles of Christ, administered it in Jordan and other rivers and places where there was much water. Both the administrators and the subjects are described as going down into, and coming up again out of, the water; and the baptized are said to be buried in baptism, and to be raised again: which language could not, they say, be properly adopted on supposition of the ordinance being administered in any other manner than by immersion. Thus also, they affirm, it was in general administered in the primitive church. Thus it is now administered in the Russian and Greek church: and thus it is, at this day, directed to be administered in the church of England, to all who are thought capable of submitting to it in this manner. With regard to the subjects of baptism, the Baptists say, that this ordinance ought not to be administered to children or infants at all, nor to grown up persons in general; but to adults only of a certain character and description. Our Saviour's commission to his apostles, by which Christian baptism was instituted, is to go and teach all nations, baptizing them: that is, say they, not to baptize all they meet with; but first to instruct them—to teach all nations, or to preach the gospel to every creature—and whoever receives it, him to baptize in the name of the Father, and of the Son, and of the Holy Ghost. To such persons, and to such only, baptism appears to have been administered by the apostles, and the immediate disciples of Christ. They are described as repenting of their sins, as believing in Christ, and as having gladly received the word. Without these qualifications, Peter acquaints those who were converted by his sermon, that he could not have admitted them to baptism, Philips holds the same language in his discourse with the eunuch; and Paul treats Lydia, the jailor, and others, in the same manner. Without these qualifications, Christians in general think it wrong to admit persons to the Lord's supper; and, for the same reasons, without these qualifications, at least a profession of them, the Baptists think it wrong to admit any to baptism. Wherefore they withhold it, not only from the impenitently vicious and profane, and from infidels who have no faith; but also from infants and children, who have no knowledge, and are incapable of every action civil and religious. They further insist, that all positive institutions depend entirely upon the will and declaration of the institutor; and therefore, that reasoning by analogy from abrogated Jewish rites is to be rejected, and the express commands of Christ respecting the mode and subjects of baptism ought to be our only rule.

The Baptists in England form one of the denominations of Protestant Dissenters. They separate from the establishment for the same reasons as their brethren of the other denominations do; and from additional motives derived from their particular tenets respecting baptism. The constitution of their churches, and their modes of worship, are congregational or independent: in the exercise of which they are protected, in common with other dissenters, by the act of toleration. Before this act, they were liable to pains and penalties as nonconformists, and often for their peculiar sentiments as Baptists. A proclamation was issued out against them, and some of them were burnt in Smithfield in 1538. They bore a considerable share in the persecutions of the last and of the preceding centuries; and, as it should seem, in those of some centuries before; for there were several among the Lollards and the followers of Wickliff, who disapproved of infant-baptism. There were many of this persuasion among the Protestants and reformers abroad. In Holland, Germany, and the North, they went by the names of Anabaptists, and Mennonites; and, in Piedmont and the south, they were found among the Albigenses and Waldenses. See the histories of the Reformation, and the above articles in this Dictionary.

The *Baptists* subsist under two denominations, viz. the *Particular* or Calvinistical, and the *General* or Arminian. The former is by far the most numerous. Some of both denominations allow of *mixed communion*, viz. of persons who have been sprinkled in their infancy, and therefore unbaptized in the view of the Baptists; others disallow it; and some of them observe the seventh day of the week as the Sabbath, apprehending the law that enjoined it not to have been repealed by Christ or his apostles. But a difference of opinion respecting these and other matters, is not peculiar

peculiar to the Baptists: it is common to all Christians, and to all bodies of men who think and judge for themselves.

BAPTISTERY, in ecclesiastical writers, a place in which the ceremony of baptism is performed.

In the ancient church it was one of the exedræ or buildings distinct from the church itself: and consisted of a pórch or anti-room where the persons to be baptized made their confession of faith, and an inner room where the ceremony of baptism was performed. Thus it continued till the sixth century, when the baptisteries began to be taken into the church-porch, and afterwards into the church itself.

The ancient baptisteries were commonly called φοτιςηρια, *photisteria*, q. d. places of illumination; an appellation sometimes given to baptism. Or they might have the name for another reason, because they were the places of an illumination, or instruction, preceding baptism: for here the catechumens seem to have been trained up, and instructed in the first rudiments of the Christian faith.

Those baptisteries were anciently very capacious; because, as Dr Cave observes, the stated times of baptism returning but seldom, there were usually great multitudes to be baptized at the same time: and then the manner of baptizing, by immersion, or dipping under water, made it necessary to have a large font likewise. In *Venantius Fortunatus*, it is called *aula baptismatis*, the large hall of baptism; which was indeed so capacious, that we sometimes read of councils meeting and sitting therein. This hall, or chapel, was always kept shut during Lent, and the door sealed up with the bishop's seal, not to be opened till Maunday-Thursday.

The baptistery was always reputed a sacred place. In the Roman order, we find the ceremonies used in the consecration of the baptisteries: they were to be built of a round figure, and distinguished with the image of St John the Baptist; over the bason or font was a figure of a dove in gold or silver, to represent the Holy Ghost.

The name *baptistery* is sometimes also given to a kind of chapel in a large church, which served for the same office. It is an observation of some learned men, that anciently there was but one baptistery in a city, and that at the bishop's church; and that afterwards they were set up in parish churches, with the special allowance however of the bishop.

BAR, in a general sense, denotes a slender piece of wood or iron, for keeping things close together.

BAR, in courts of justice, an enclosure made with a strong partition of timber, where the counsel are placed to plead causes. It is also applied to the benches where the lawyers or advocates are seated, because anciently there was a bar to separate the pleaders from the attorneys and others. Hence our lawyers who are called to the bar, or licensed to plead, are termed *barristers*, an appellation equivalent to *licentiate* in other countries.

BAR, or *Barr*, (Latin *barra*, and in French *barre*), in a legal sense, is a plea or peremptory exception of a defendant, sufficient to destroy the plaintiff's action. And it is divided into bar to common intendment, and bar special; bar temporary, and perpetual. Bar to a common intendment is an ordinary or general bar, which usually disableth the declaration of the plaintiff; bar special is that which is more than ordinary, and falls out upon some special circumstance of the fact as to the case in hand. Bar temporary is such a bar as is good for the present, but may afterwards fail; and bar perpetual is that which overthrows the action of the plaintiff for ever.

BAR, in *Heraldry*, an ordinary in form of the fess, but much less. See HERALDRY.

BAR, in the *Manege*, the highest part of that place of a horse's mouth situated between the grinders and tushes, so that the part of the mouth which lies under and at the side of the bars retains the name of the gum. A horse with sensible bars has a fine light mouth, with an even and firm appui. See APPUI.

To BAR a Vein, in *Farriery*, is an operation performed upon the veins of the legs of a horse and other parts, with intent to stop the malignant humours. It is done by opening the skin above it, disengaging it, and tying it both above and below, and striking between the two ligatures.

BAR, in *Music*, a stroke drawn perpendicularly across the lines of a piece of music, including between each two a certain quantity or measure of time, which is various as the time of the music is either triple or common. In common time, between each two bars is included the measure of four crotchets; in triple, three. The principal use of bars is to regulate the beating of time in a concert. The use of bars is not to be traced higher than the time when the English translation of Adrian le Roy's book on the Tablature was published, viz. the year 1574; and it was some time after that before the use of bars became general. To come nearer to the point, Barnard's cathedral music, printed in 1641, is without bars; but bars are to be found throughout in the *Ayres and Dialogues* of Henry Lawes published in 1653; from whence it may be conjectured that we owe to Lawes this improvement.

BAR, in *Hydrography*, denotes a bank of sand, or other matter, whereby the mouth of a river is in a manner choked up.

The term *bar* is also used for a strong beam wherewith the entrance of a harbour is secured: this is more commonly called *boom*.

BAR of a tavern or coffeehouse, the place where the waiters attend to answer the calls of the customers.

BAR, among printers, denotes a piece of iron with a wooden handle, whereby the screw of the press is turned in printing. See PRINTING.

BARS of Iron, are made of the metal of the sows and pigs as they come from the furnace. These pass through two forges called the *finery* and the *chaufery*; where, undergoing five several heats, they are formed into bars.

BAR, a very strong city of Podolia in Poland, upon the river Kiow. E. Long. 28. 30. N. Lat. 50. 6.

BAR, formerly a duchy of France, now the department of Meuse, is bounded on the east by Lorrain, on the north by Luxembourg, on the west by Champagne, on the south by part of the same country, and by Franche Compte. It is crossed by the river Meuse from north to south, and watered by several other rivers, which render it very fertile. It was divided into four balliages, viz. Bassilyni, Bar, St Michael, and

Bar-le-duc || Bara.

and Clermont. The chief towns are Bar-le-duc, Clermont, St Michael, Longuey, Pont a Mousson, and Stenay. In 1736, it was given to Stanislaus then king of Poland.

Bar-le-duc, the capital of the late duchy of Bar, in the department of Meuse, is seated on the declivity of a hill. It is divided into the higher and lower town: the lower is watered by the rivulet Orney, which abounds with excellent trouts. The wines are excellent, and not inferior to those of Champagne. E. Long. 5. 30. N. Lat. 48. 35.

Bar-le-Mont, a town of the French Netherlands, in Hainault, situated on the river Sombre. E. Long. 3. 40. N. Lat. 50. 10.

Bar sur Aube, an ancient town of France, in the department of Aube, seated at the foot of a mountain. It is much celebrated for excellent wines. E. Long. 4. 50. N. Lat. 48. 14.

Bar sur Seine, a town of France, in the duchy of Burgundy, now in the department of Aube, seated between a mountain which covers it on the west, and the river Seine which runs on the east. E. Long. 4. 30. N. Lat. 48. 5.

Bar-Master, among miners, the person who keeps the gauge, or dish, for measuring the ore.

BARA, in *Ancient Geography*, a small island in the Adriatic, opposite to Brundusium: the *Pharos* of Mela. Also a frith or arm of the sea of Britannia Secunda (Ptolemy); supposed to be the Murray frith.

Bara, one of the Hebrides or Western islands of Scotland. It is a small rock, only a quarter of a mile in circumference, being part of a chain called the *Long Island*, the whole cluster appearing at low water as one island. Bara is altogether barren; but abounds with great numbers of sea-fowl, such as solan geese, guillamotes, puffins, &c.

Bara, the name of a festival celebrated with much magnificence at Messina, and representing the assumption of the Virgin. The *bara*, though used as the general denomination of this festival, signifies more particularly a vast machine 50 feet high, at the top of which a young girl of 14, representing the Virgin, stands upon the hand of an image of Jesus Christ. Round him turn vertically, in a circle, 12 little children which represent the seraphims; below them, in another circle, which turns horizontally, are 12 more representing the cherubims: below these a sun turns vertically, with a child at the extremity of each of the four principal *radii* of his circle, who ascend and descend with his rotation, yet still stand upright. Below the sun is the lowest circle, about seven feet from the ground, in which 12 boys turn horizontally without interruption; these are intended for the twelve apostles, who are supposed to surround the tomb of the Virgin at the moment when she ascends into heaven. This complication of superstitious whirligigs may have already nearly turned the stomachs of some of our readers, or at least rendered them squeamish. But think of the poor little cherubims, seraphims, and apostles, who are twirled about in this procession! for, says Mr Houel "some of them fall asleep, many of them vomit, and several do still worse:" but these unseemly effusions are no drawback upon the edification of the people; and nothing is more common than to see fathers and mothers soliciting with ardour for their boys and girls the pious distinction of puking at the bara. This machine is not drawn by asses or mules, but by a multitude of robust monks.

Houel's Descriptive Travels through Sicily, &c.

Barabinzians || Baratiere.

BARABINZIANS, a tribe of Tartars, living on both sides of the river Irtis. They seem to derive their name from the *Barabaian* desert, whose lakes supply them abundantly with fish, on which and their cattle they chiefly subsist. They have plenty of game and wild-fowl of every kind, particularly ducks and puffins. Most of them are heathens, but Mahometanism daily gains ground among them. Some of them pay tribute to the empress of Russia, and others to the Khan Taisha.

BARACOA, a town in the north-east part of the island of Cuba. W. Long. 76. 10. N. Lat. 21. 5.

BARALIPTON, among logicians, a term denoting the first indirect mode of the first figure of syllogism. A syllogism in baralipton, is when the two first propositions are general, and the third particular, the middle term being the subject in the first proposition and the predicate in the second. The following is of this kind:

Ba. Every evil ought to be feared;
ra. Every violent passion is an evil;
lip. Therefore something that ought to be feared is a violent passion.

BARALLOTS, in *Church History*, a sect of heretics at Bologna in Italy, who had all things in common, even their wives and children. Their facility in complying with all manner of debauchery made them get the name *obedientes*, "compliers."

BARANCA de malambo, a town of Terra Firma in America, with a bishop's see and a good haven. It is a place of great trade, and is seated on the river Magdaline. W. Long. 75. 30. N. Lat. 11. 10.

BARANGI, officers among the Greeks of the lower empire. Cujas calls them in Latin *protectores*, and others give them the name of *securigeri*. It was their business to keep the keys of the city gates, where the emperor resided.

BARANWAHR, a town of Lower Hungary, in a county of the same name, taken by the emperor of Germany from the Turks in 1684. It is seated between Buda and Belgrade, in E. Long. 10. 5. N. Lat. 46. 0.

BARATHRUM, in *Antiquity*, a deep dark pit at Athens, into which condemned persons were cast headlong. It had sharp spikes at the top, that no man might escape out; and others at the bottom, to pierce and torment such as were cast in. Its depth and capaciousness made it to be applied proverbially to a covetous person: to a glutton, called *Barathro* by the Romans (Lucretius, Horace), and *Barathrum* in the same sense (Horace); and for a common prostitute (Plautus).

BARATIERE, Philip, a most extraordinary instance of the early and rapid exertion of mental faculties. This surprising genius was the son of Francis Baratiere, minister of the French church at Schwobach near Nuremberg, where he was born Jan. 10th 1721. The French was his mother tongue, together with some words of High Dutch; but by means of his father insensibly talking Latin to him, it became as familiar to him as the rest: so that, without knowing the rules of grammar, he at four years of age talked French to his

mother,

Baratiere, Baratz.

mother, Latin to his father, High Dutch to the maid or neighbouring children; and all this without mixing or confounding the respective languages. About the middle of his fifth year he acquired Greek in like manner; so that in 15 months he perfectly understood all the Greek books in the Old and New Testament, which he readily translated into Latin. When he was five years and eight months old, he entered upon Hebrew; and in three years time was so expert in the Hebrew text, that from a bible without points, he could give the sense of the original in Latin or French; or translate extempore the Latin or French versions into Hebrew, almost word for word; and had all the Hebrew psalms by heart. He composed at this time a dictionary of rare and difficult Hebrew words, with critical remarks and philological observations, in about 400 pages in 4to; and, about his tenth year, amused himself for twelve months with the Rabbinical writers. With these he intermixed a knowledge of the Chaldaic, Syriac, and Arabic; and acquired a taste for divinity and ecclesiastical antiquity, by studying the Greek fathers, and councils of the first four ages of the church. In the midst of these occupations, a pair of globes coming into his possession, he could in 8 or 10 days time resolve all the problems on them; and in about three months, in Jan. 1735, devised his project for the discovery of the longitude, which he communicated to the Royal Society at London and the Royal Academy of Sciences at Berlin. In June 1731, he was matriculated in the university of Alstorf; and at the close of the year 1732, he was presented by his father at the meeting of the reformed churches of the circle of Franconia; who, astonished at his wonderful talents, admitted him to assist in the deliberations of the synod; and to preserve the memory of so singular an event, it was ordered to be registered in their acts. In 1734, the margrave of Brandenburgh Anspach granted this young scholar the use of whatever books he wanted from the Anspach library, together with a pension of 50 florins, which he enjoyed three years; and his father receiving a call to the French church at Stetin in Pomerania, young Baratiere was, on the journey, admitted master of arts, with universal applause, at the university of Hall: at Berlin he was honoured with several conversations with the king of Prussia, and was received into the Royal Academy. Towards the close of his life he acquired a taste for medals, inscriptions, and antiquities; metaphysical inquiries, and experimental philosophy, intervening occasionally between these studies. He wrote several essays and dissertations; made astronomical remarks, and laborious calculations; took great pains toward a history of the heresies of the anti-trinitarians, and of the 30 years war in Germany: his last publication, which appeared in 1740, was on the succession of the bishops of Rome. The final work he engaged in, and for which he had gathered large materials, was *Inquiries concerning the Egyptian Antiquities*. But the substance of this blazing meteor was now almost exhausted: he was always weak and sickly; and died October 5. 1740, aged 19 years 8 months and 16 days. He published 11 different pieces, and left 29 manuscripts on various subjects, the contents of which may be seen in his life written by M. Formey professor of philosophy at Berlin.

BARATZ, Turkish, letters-patent granted by the Turkish emperors to the Greek patriarch, bishops, &c. for the exercise of their ecclesiastical functions. This *Baratz* gives the bishops full power and authority to establish and depose the inferior clergy, and all other religious persons; to grant licenses for marriages, and issue out divorces; to collect the revenues belonging to the churches; to receive the pious legacies bequeathed to them; in short, to enjoy all the privileges and advantages belonging to their high station: and all this (as it is expressed in the baratz itself) "according to the vain and idle ceremonies of the Christians."

Barb || Barbadoes.

BARB, or Barbe, a horse brought from Barbary, See Equus, Mammalia *Index*.

BARBA, in *Botany*, a species of *pubes*, or down, with which the surface of some plants is covered. The term was invented by Linnæus; and by its application in the *Species Plantarum*, seems to signify a tuft or bunch of strong hairs terminating the leaves. *Mesembryanthemum barbatum* furnishes an example.

The word is also often used in composition with some other, to form the trivial names of several plants, as *barba jovis*, *barba capræ*, &c.

BARBACAN, or Barbican, an outer defence or fortification to a city or castle, used especially as a fence to the city or walls; also an aperture made in the wall of a fortress, to fire through upon the enemy. See Castle.

Barbacan is also used to denote a fort at the entrance of a bridge, or the outlet of a city, having a double wall with towers.

BARBADOES, the most easterly of all the Caribbee islands, subject to Great Britain, and, according to the best geographers, lying between 59° 50′ and 60° 2′ of west longitude, and between 12° 56′ and 13° 16′ of north latitude. Its extent is not certainly known: the most general opinion is, that it is 25 miles from north to south, and 15 from east to west; but these mensurations are subject to so many difficulties and uncertainties, that it will perhaps convey a more adequate idea of this island to tell the reader that in reality it does not contain above 107,000 acres. The climate is hot, but not unwholesome, the heat being qualified by sea-breezes; and a temperate regimen renders this island as safe to live in as any climate south of Great Britain; and, according to the opinion of many, as even Great Britain itself. This island has on its east side two streams that are called *rivers*, and in the middle is said to have a bituminous spring which sends forth a liquor like tar, and serves for the same uses as pitch or lamp-oil. The island abounds in wells of good water, and has several reservoirs for rain-water. Some parts of the soil are said to be hollowed into caves, some of them capable of containing 300 people. These are imagined to have been the lurking-places of runaway negroes, but may as probably be natural excavations. The woods that formerly grew upon the island have been all cut down, and the ground converted into sugar plantations. When those plantations were first formed, the soil was prodigiously fertile, but has since been worn out, insomuch, that about the year 1730, the planters were obliged to raise cattle for the sake of their dung, by which means the profit of their plantations was reduced to less than a tenth of its usual value. Notwithstanding the smallness of Barbadoes, its soil is different;

Barbadoes. different; being in ſome places ſandy and light, and others rich, and in others ſpongy; but all of it is cultivated according to its proper nature, ſo that the iſland preſents to the eye the moſt beautiful appearance that can be imagined. Oranges and lemons grow in Barbadoes in great plenty, and in their utmoſt perfection. The lemon juice here has a peculiar fragrancy. The citrons of Barbadoes afford the beſt drams and ſweetmeats of any in the world, the Barbadoes ladies excelling in the art of preſerving the rind of the citron fruit. The juice of the limes, or dwarf lemons, is the moſt agreeable ſouring we know, and great quantities of it have of late been imported into Britain and Ireland. The pine apple is alſo a native of Barbadoes, and grows there to much greater perfection than it can be made to do in Europe by any artificial means. A vaſt number of different trees peculiar to the climate are alſo found to flouriſh in Barbadoes in great perfection; ſuch as the aloe, mangrove, calabaſh, cedar, cotton, maſtich, &c. Here likewiſe are produced ſome ſenſitive plants, with a good deal of garden ſtuff, which is common in other places. In ſhort, a native of the fineſt, the richeſt, and moſt diverſified country in Europe, can hardly form an idea of the variety of delicious and at the ſame time nutritive vegetable productions with which this iſland abounds.

When Barbadoes was firſt diſcovered by the Engliſh, few or no quadrupeds were found upon it, except hogs, which had been left there by the Portugueſe. For convenience of carriage to the ſea ſide, ſome of the planters at firſt procured camels; which undoubtedly would in all reſpects have been preferable to horſes for their ſugar and other works; but the nature of the climate diſagreeing with that animal, it was found impoſſible to preſerve the breed. They then applied for horſes to Old and New England: from the former they had thoſe that were fit for ſhow and draught; from the latter thoſe that were proper for mounting their militia, and for the ſaddle. They had likewiſe ſome of an inferior breed from Curaſſao, and other ſettlements. They are reported to have had their firſt breed of black cattle from Bonaviſta and the iſle of Mayo; they now breed upon the iſland, and often do the work of horſes. Their aſſes are very ſerviceable in carrying burdens to and from the plantations. The hogs of Barbadoes are finer eating than thoſe of Britain, but the few ſheep they have are not near ſo good. They likewiſe have goats, which when young are excellent food. Racoons and monkeys are alſo found here in great abundance. A variety of birds are produced on Barbadoes, of which the humming bird is the moſt remarkable. Wild fowl do not often frequent this iſland: but ſometimes teal are found near their ponds. A bird which they call the *man of war*, is ſaid to meet ſhips at 20 leagues from land, and their return is, to the inhabitants, a ſure ſign of the arrival of theſe ſhips. When the wind blows from the ſouth and ſouth-weſt, they have flocks of curlews, plovers, ſnipes, wild pigeons, and wild ducks. The wild pigeons are very fat and plentiful at ſuch ſeaſons, and rather larger than thoſe of England. The tame pigeons, pullets, ducks, and poultry of all kinds, that are bred at Barbadoes, have alſo a fine flavour, and are accounted more delicious than thoſe of Europe. Their rabbits are ſcarce; they have no hares; and if they have deer of any kind, they are kept as curioſities. The inſects of Barbadoes are not venomous, nor do either their ſnakes or ſcorpions ever ſting. The muſkettoes are troubleſome, and bite, but are more tolerable in Barbadoes than on the continent. Various other inſects are found on the iſland, ſome of which are troubleſome, but in no greater degree than thoſe that are produced by every warm ſummer in England. Barbadoes is well ſupplied with fiſh; and ſome caught in the ſea ſurrounding it are almoſt peculiar to itſelf; ſuch as the parrot-fiſh, ſnappers, grey cavallos, terbums, and coney-fiſh. The mullets, lobſters, and crabs, caught here are excellent; and the green turtle is perhaps the greateſt delicacy that ancient or modern luxury can boaſt of. At Barbadoes this delicious ſhell-fiſh ſeldom ſells for leſs than a ſhilling a pound, and often for more. There is found in this iſland a kind of land crab which eats herbs wherever it can find them, and ſhelters itſelf in houſes and hollows of trees. According to report, they are a ſhell-fiſh of paſſage; for in March they travel to the ſea in great numbers. See CANCER.

The inhabitants may be reduced to three claſſes; viz. the maſters, the white ſervants, and the blacks. The former are either Engliſh, Scots, or Iriſh: but the great encouragement given by government to the peopling of this and other Weſt Indian iſlands, induced ſome Dutch, French, Portugueſe, and Jews, to ſettle among them with their eſtates; by which, after a certain time, they acquire the rights of naturalization in Great Britain. The white ſervants, whether by covenant or purchaſe, lead more eaſy lives than the day-labourers in England; and when they come to be overſeers, their wages and other allowances are conſiderable. As to the treatment of the negro ſlaves in this and the other iſlands, that falls to be ſpoken of under the articles NEGRO, SLAVE, WEST-INDIES; which ſee. The manners of the white inhabitants, in general, are the ſame as in moſt polite towns and counties in Europe. The capital of the iſland is called *Bridge-Town*; ſee that article.

As the hiſtory of this iſland furniſhes no very remarkable events, the following ſhort hints concerning it may ſuffice.

When the Engliſh, ſome time after the year 1625, firſt landed here, they found it the moſt ſavage and deſtitute place they had hitherto viſited. It had not the leaſt appearance of ever having been peopled even by ſavages. There was no kind of beaſts of paſture or of prey, no fruit, no herb, no root fit for ſupporting the life of man. Yet as the climate was ſo good, and the ſoil appeared fertile, ſome gentlemen of ſmall fortune in England reſolved to become adventurers thither. The trees were ſo large, and of a wood ſo hard and ſtubborn, that it was with great difficulty they could clear as much ground as was neceſſary for their ſubſiſtence. By unremitting perſeverance, however, they brought it to yield them a tolerable ſupport; and they found that cotton and indigo agreed well with the ſoil; and that tobacco, which was beginning to come into repute in England, anſwered tolerably. Theſe proſpects, together with the ſtorm between the king and parliament, which was beginning to break out in England, induced many new adventurers to tranſport themſelves into this iſland. And what is extremely

tremely remarkable, ſo great was the increaſe of people in Barbadoes, 25 years after its firſt ſettlement, that in 1650 it contained more than 50,000 whites, and a much greater number of negro and Indian ſlaves. The latter they acquired by means not at all to their honour: for they ſeized upon all thoſe unhappy men, without any pretence, in the neighbouring iſlands, and carried them into ſlavery; a practice which has rendered the Caribbee Indians irreconcilable to us ever ſince. They had begun a little before this to cultivate ſugar, which ſoon rendered them extremely wealthy. The number of ſlaves, therefore, was ſtill augmented; and in 1676 it is ſuppoſed that their number amounted to 100,000, which, together with 50,000 whites, make 150,000 on this ſmall ſpot: a degree of population unknown in Holland, in China, or any other part of the world moſt renowned for numbers. At this time Barbadoes employed 400 ſail of ſhips, one with another of 150 tons, in their trade. Their annual exports, in ſugar, indigo, ginger, cotton, and citron-water, were above 350,000l. and their circulating caſh at home was 200,000l. Such was the increaſe of population, trade, and wealth, in the courſe of 50 years. But ſince that time this iſland has been much on the decline; which is to be attributed partly to the growth of the French ſugar colonies, and partly to our own eſtabliſhments in the neighbouring iſles. Their numbers at preſent are ſaid to be 20,000 whites and 100,000 ſlaves. Their commerce conſiſts of the ſame articles as formerly, though they deal in them to leſs extent.

Barbadoes-Tar, a mineral fluid of the nature of the thicker fluid bitumens, of a nauſeous bitteriſh taſte, very ſtrong and diſagreeable ſmell, found in many parts of America trickling down the ſides of the mountains, and ſometimes floating on the ſurface of the waters. It has been greatly recommended in coughs and other diſorders of the breaſt and lungs.

BARBARA, among *Logicians*, the firſt mode of the firſt figure of ſyllogiſms. A ſyllogiſm in barbara is one whereof all the propoſitions are univerſal and affirmative; the middle term being the ſubject of the firſt propoſition, and attribute in the ſecond.

Examp. Bar. Every wicked man is miſerable;
Ba. All tyrants are wicked men;
Ra. Therefore all tyrants are miſerable.

BARBARIAN, a name given by the ancient Greeks and Romans to all who were not of their own country, or were not initiated in their language, manners, and cuſtoms. In this ſenſe, the word ſignified with them no more than foreigner; not ſignifying, as among us, a wild, rude, or uncivilized perſon.

BARBARISM, in a general ſenſe, a rudeneſs of language or behaviour.

Barbarism, in *Grammar*, an offence againſt the purity of ſtyle or language; or an ungrammatical way of ſpeaking or writing, contrary to the true idiom of any particular language.

BARBAROSSA, Aruch, and Hayradin, two famous corſairs, the ſons of a potter in the iſle of Leſbos; who, turning pirates, carried on their depredations with ſuch ſucceſs and conduct, that they were ſoon poſſeſſed of 12 galleys beſides ſmaller veſſels. Of this fleet Aruch the elder brother, called *Barbaroſſa* from the redneſs of his beard, was admiral, and Hayradin the ſecond in command: they called themſelves the *friends of the ſea*, and the *enemies of all who ſailed upon it*; and their names became terrible from the ſtraits of Dardanelles to thoſe of Gibraltar. With ſuch a power they wanted an eſtabliſhment; and the opportunity of ſettling themſelves offered in 1516, by the inconſiderate application of Eutemi king of Algiers to them for aſſiſtance againſt the Spaniards. Aruch, leaving his brother to command the fleet, carried 5000 men to Algiers, where he was received as their deliverer; and ſecretly murdering the prince he came to aid, cauſed himſelf to be proclaimed king in his ſtead. To this uſurpation he added the conqueſt of Tremecen; when his exploits and piracies induced the emperor Charles V. to furniſh the marquis de Gomarez governor of Oran with troops to ſuppreſs him; by whom he was defeated and killed near Tremecen. His brother Hayradin, known alſo by the name of *Barbaroſſa*, aſſumed the ſceptre at Algiers with the ſame abilities, and with better fortune; for the Spaniards, ſufficiently employed in Europe, giving him no diſturbance he regulated the interior police of his kingdom with great prudence, carried on his naval operations with vigour, and extended his conqueſts on the continent of Africa. He put his dominions under the protection of the Grand Signior, Solyman the Magnificent; and obtained the command of the Turkiſh fleet. With ſo powerful a protector, he acquired the kingdom of Tunis in a manner ſimilar to that by which his brother gained Algiers. Since the time of the Barbaroſſas, Algiers has been underſtood to be dependent on the Porte; but this dependence is now little more than merely nominal.

BARBARUS, Francis, a noble Venetian, was a man of great fame in the 15th century, not only for learning, but likewiſe for a ſkilful addreſs in the management of public affairs. He is author of a book *De Re Uxoria*, and ſome ſpeeches.

Barbarus, *Hermolaus*, grandſon of the preceding, one of the moſt learned men in the 15th century. The public employments he was intruſted with early, did not prevent him from cultivating polite learning with great application. As he was very ſkilful in the Greek, he undertook the moſt difficult tranſlations, and began with a famous paraphraſe upon Ariſtotle. He then attempted Dioſcorides, whoſe text he corrected, gave a tranſlation of him, and added a commentary. But of all his works, there is none which has gained him ſo much reputation as that which he made upon Pliny; he corrected in him above 5000 paſſages, and occaſionally reſtored 300 in Pomponius Mela. Pope Innocent VIII. to whom he was ambaſſador, conferred the partriarchate of Aquileia upon him. He was ſo imprudent as to accept of it without waiting for the conſent of his ſuperiors; though he could not be ignorant that the republic of Venice had made laws to forbid all the miniſters they ſent to the court of Rome to accept any benefice. His ſuperiors were inflexible; and not being able to gain any thing upon them either by his flattery or his father's intereſt, the father died of grief, and the ſon ſoon followed him.

Barbarus, *Daniel*, of the ſame family with the preceding, was patriarch of Aquileia, and famous for his learning. He was ambaſſador from Venice to England;

land; and was one of the fathers of the council of Trent, where he acted with great zeal for the interest of the pope. He wrote, 1. A commentary upon Vitruvius. 2. *Catena Græcorum Patrum in quinquaginta Psalmos Latine versa*. 3. *La Pratica della Perspectiva*. He died in 1569, at 41 years of age.

BARBARY, a kingdom of Africa, including the states of *Algiers*, *Morocco*, *Tripoli*, and *Tunis*; (see those articles). This country contains almost the whole of what the Romans possessed of the continent of Africa, excepting Egypt.

1
Extent, &c.

It stretches itself in length from east to west, beginning at the southern limits of Egypt, to the straits of Gibraltar full 35 degrees of longitude; and from thence to Santa Cruz, the utmost western edge of it, about six more, in all 41 degrees; so that the utmost length of Barbary from east to west is computed at above 759 German leagues. On the south, indeed, it is confined within much narrower bounds, extending no farther than from 27 to 35¼ degrees of north latitude; so that its utmost breadth from north to south, does not exceed 128 German miles. More particularly, Barbary begins on the west of the famed Mount Atlas, called by the Arabs *Ay Duacal*, or *Al Duacal*, enclosing the ancient kingdoms of Suez and Dela, now provinces of Morocco; thence stretching north-eastward along the Atlantic to the pillars of Hercules at Cape Finisterre, then along the coast of the Mediterranean, it is at last bounded by the city of Alexandria in Egypt.

2
Whence named.

Concerning the origin of the name *Barbary*, there are many conjectures. According to some, the Romans, after they had conquered this large country, gave it that name out of contempt and dislike to the barbarous manners of the natives, according to their custom of calling all other people but themselves *Barbarians*. Marmol on the contrary, derives the word *Barbary* from *Berber*, a name which the Arabs gave to its ancient inhabitants, and which they retain to this day in many parts of the country, especially along the great ridge of the mountains of Atlas; and which name was given them on account of the barrenness of their country. According to Leo Africanus, the name of Barbary was given by the Arabs on account of the strange language of the natives, which appeared to them more like a murmur or grumbling of some brute animals than articulate sounds. Others, however, derive it from the Arabic word *bar*, signifying a desert, twice repeated; which was given by one *Ifric*, or *Africus*, a king of Arabia, from whom the whole continent of Africa is pretended to have taken its name. According to them, this king being driven out of his own dominions, and closely pursued by his enemies, some of his retinue called out to him *Bar*, *Bar*; that is, *To the desert*, *To the desert*; from which the country was afterwards called *Barbary*.

3
Subject to the Romans.

Among the Romans this country was divided into the provinces of Mauritania, Africa Propria, &c. and they continued absolute masters of it from the time of Julius Cæsar till the year of Christ 428. At that time Bonifacius the Roman governor of these provinces, having through the treachery of Ætius been forced to revolt, called in to his assistance Genseric king of the Vandals, who had been some time settled in Spain.

4
Bonifacius calls in the Vandals.

The terms offered, according to Procopius, were, that Genseric should have two thirds, and Bonifacius one third, of Africa, provided they could maintain themselves against the Roman power; and to accomplish this they were to assist each other to the utmost.—This proposal was instantly complied with; and Genseric set sail from Spain in May 428, with an army of 80,000 men, according to some, or only 24,000 according to others, together with their wives, children, and all their effects. In the mean time, however, the empress Placidia having discovered the true cause of Bonifacius's revolt, wrote a most kind and obliging letter to him, in which she assured him of her favour and protection for the future, exhorting him to return to his duty, and exert his usual zeal for the welfare of the empire, by driving out the Barbarians whom the malice of his enemies had obliged him to call in for his own safety and preservation.

5
Endeavours unsuccessfully to persuade them to return.

Bonifacius readily complied with this request, and offered the Vandals considerable sums if they would retire out of Africa and return to Spain. But Genseric, already master of the greatest part of the country, first returned a scoffing answer, and then, falling unexpectedly on him, cut most of his men to pieces, and obliged Bonifacius himself to fly to Hippo, which place he invested in May 430. The siege lasted till the month of July the following year; when the Vandals were forced, by a famine that began to rage in their camp, to drop the enterprise, and retire. Soon after, Bonifacius having received two reinforcements, one from Rome, and the other, under the conduct of the celebrated Aspar, from Constantinople, a resolution was taken by the Roman generals to offer the enemy battle.

6
Romans defeated by Genseric king of the Vandals.

The Vandals readily accepting the challenge, a bloody engagement ensued, in which the Romans were utterly defeated, a prodigious number of them taken, and the rest obliged to shelter themselves among the rocks and mountains. Aspar, who commanded the eastern troops, escaped with difficulty to Constantinople, and Bonifacius was recalled to Italy. Upon their departure, the Vandals overran all Africa, committing everywhere the most terrible ravages; which struck the inhabitants of Hippo with such terror, that they abandoned their city, which was first plundered, and then set on fire by the victorious enemy; so that Cirtha and Carthage were now the only strong places possessed by the Romans.

7
Peace concluded with the Vandals.

In 435, Genseric, probably being afraid of an attack by the united forces of the eastern and western empires, concluded a peace with the Romans, who yielded to him part of Numidia, the province of Proconsularis, and likewise Byzancene; for which, according to Prosper, he was to pay a yearly tribute to the emperor of the east. Genseric delivered up his son Hunneric by way of hostage; but so great was the confidence which the Romans placed in this Barbarian, that some time after they sent him back his son. Of this they soon had reason to repent; for in 439, the Romans being engaged in a war with the Goths in Gaul, Genseric laid hold of that opportunity to seize upon the city of Carthage; by which he considerably enlarged his African dominions.

8
Genseric's treachery.

Valentinian, the Roman emperor, however, maintained as long as he lived the two Mauritanias, with Tripolitana, Tingitana, and that part of Numidia where Cirtha stood.

On the taking of Carthage, Genseric made it the seat of his empire; and in 440 made a descent on the island

Barbary. island of Sicily, where he ravaged the open country, and even laid siege to Palermo. Not being able, however, to reduce that place, he soon returned to Africa with an immense booty and a vast number of captives. Being now become formidable to both empires, Theodosius emperor of the east resolved to assist Valentinian against so powerful an enemy. Accordingly, he fitted out a fleet consisting of 1100 large ships; and putting on board of it the flower of his army, under the conduct of Arcovindas, Ansilus, and Germanus, he ordered them to land in Africa, and, joining the western forces there, to drive Genseric out of the countries he had seized. But Genseric in the mean time pretending a desire to be reconciled with both empires, amused the Roman general with proposals of peace, till the season for action was over; and, next year, Theodosius being obliged to recal his forces to oppose the Huns, Valentinian found it necessary to conclude a peace with the Vandals; and this he could obtain on no other terms than yielding to them the quiet possession of the countries they had seized.

So powerful was Genseric now become, or rather so low was the Roman empire by this time reduced, that in 4 5 he took and plundered the city of Rome itself, as is fully related under the article ROME; and, after his return to Africa, made himself master of the remaining countries held by the Romans in that part of the world. Hereupon Avitus, who had succeeded Valentinian in the empire, despatched ambassadors to Genseric, putting him in mind of the treaty he had concluded with the empire in 442; and threatening, if he did not observe the articles at that time agreed upon, to make war upon him not only with his own forces, but with those of his allies the Vesigoths, who were ready to pass over into Africa. To this Genseric was so far from paying any regard, that he immediately put to sea with a fleet of 60 ships; but being attacked by the Roman fleet under Ricimer, he was utterly defeated, and forced to fly back into Africa: he returned, however, soon after with a more powerful fleet, committing great ravages on the coast of Italy; but in a second expedition he was not attended with so good success; the Romans falling unexpectedly upon his men while busied in plundering the country, put great numbers of them to the sword, and among the rest the brother-in-law of Genseric himself. Not content with this small advantage, Majorianus, at that time emperor, resolved to pass over into Africa, and attempt the recovery of that country. For this purpose he made great preparations; but his fleet being surprised and defeated by the Vandals, through the treachery, it is said, of some of his commanders, the enterprise miscarried.

9 Makes himself master of all the Roman provinces.

10 Defeated by Ricimer and Majorianus.

Notwithstanding this misfortune, however, Majorianus persisted in his resolution; and would in all likelihood have accomplished his purpose, had not he himself been murdered soon after by Ricimer. After his death, Genseric committed what ravages he pleased in the poor remains of the western empire, and even made descents on Peloponnesus and the islands belonging to the emperor of Constantinople. To revenge this affront, Leo made vast preparations for the invasion of Africa, insomuch, that, according to Procopius, he laid out 130,000 pounds weight of gold in the equipment of his army and navy. The forces employed on this occasion were sufficient for expelling the Vandals, had they been much more powerful than they were; but the command being given to Basiliscus a covetous and ambitious man, the fleet was utterly defeated through his treachery, and all the vast preparations came to nothing. By this last defeat the power of the Vandals in Africa was fully established, and Genseric made himself master of Sicily, as well as of all the other islands between Italy and Africa, without opposition from the western emperors, whose power was entirely taken away in the year 476.

11 Genseric defeats the eastern emperor's fleet.

Thus was the Vandalic monarchy in Barbary founded by Genseric, between the years 428 and 468. If we take a view of that prince's government in his new dominions, it presents no very agreeable prospect. Being himself an absolute barbarian in the strictest sense of the word, and an utter stranger to every useful art, he did not fail to show his own prowess by the destruction of all the monuments of Roman greatness which were so numerous in the country he had conquered. Accordingly, instead of improving his country, he laid it waste, by demolishing all the stately structures both public and private, and all other valuable and sumptuous works with which those proud conquerors had adorned this part of their dominions. So that, whatever monuments the Romans had been at such an immense expence to erect, in order to eternize their own glory, the barbarous Vandals were now at no less pains to reduce into heaps of ruins. Besides this kind of devastations, Genseric made his dominions a scene of blood and slaughter, by persecuting the orthodox Christians; being himself, as well as most of his countrymen, a zealous Arian; and for this his long reign is chiefly remarkable. He died in 477, after a reign of 60 years; and was succeeded by his son Hunneric.

12 Kingdom of the Vandals founded.

13 Barbarity and tyranny of Genseric.

The new king proved yet a greater tyrant than his father, persecuting the orthodox with the utmost fury; and, during his short reign of seven years and a half, destroyed more of them than Genseric had done in all his lifetime. He is said to have died in the same manner as the heresiarch Arius *; before which time his flesh had been rotting upon his bones, and crawling with worms, so that he looked more like a dead carcase than a living man. Concerning his successors Gutamund, Thrasamund, and Hilderic, we find nothing remarkable, except that they sometimes persecuted, and sometimes were favourable to, the orthodox; and by his favour for them the last king was ruined. For, having unadvisedly published, in the beginning of his reign, a manifesto, wherein he repealed all the acts of his predecessors against the orthodox, a rebellion was the immediate consequence. At the head of the malcontents was one Gilimer, or Gildemar, a prince of the blood-royal, who by degrees became so powerful, as to depose Hilderic in the seventh year of his reign; after which he caused the unhappy monarch, with all his family, to be closely confined, and was himself crowned king of the Vandals at Carthage.

14 Hunneric a bloody tyrant.

15 His terrible death.

* See *Arius*.

16 Hilderic deposed by Gilimer.

Gilimer proved a greater tyrant than any that had gone before him. He not only cruelly persecuted the orthodox, but horribly oppressed all the rest, so that he was held in universal abhorrence and detestation when the Greek emperor Justinian projected an invasion of Africa. This expedition of Justinian's is said to have

17 Belisarius invades Africa;

Barbary.

have been occaſioned by an apparition of Lætus an African biſhop, who had been murdered ſome time before, but now commanded the emperor to attempt the recovery of Africa, and aſſured him of ſucceſs. Accordingly, this, or ſome other motive, prevailed upon Juſtinian ſo far, that, notwithſtanding his being at that time engaged in a war with Perſia, he ſent a powerful fleet and army to Africa, under the command of the celebrated general Beliſarius, who was for that reaſon recalled from Perſia.

So much was Gilimer, all this time, taken up with his own pleaſures, or with oppreſſing his ſubjects, that he knew little or nothing of the formidable preparations that were making againſt him. On the arrival of Beliſarius, however, he was conſtrained to put himſelf into a poſture of defence. The management of his army he committed to his two brothers Gundimer and Gelamund, who accordingly attacked the Romans at

18 defeats the Vandals; the head of a numerous force. The engagement was long and bloody; but at laſt the Vandals were defeated, and the two princes ſlain. Gilimer, grown deſperate at this news, ſallied out at the head of his corps de reſerve, with full purpoſe to renew the attack with the utmoſt vigour; but by his own indiſcretion loſt a fair opportunity of defeating the Romans. For no ſooner did they perceive Gilimer haſtening after them at the head of a freſh army, than they betook themſelves to flight; and the greateſt part were diſperſed in ſuch a manner, that, had the king followed them cloſe, they muſt have been totally cut off. Inſtead of this, however, ſtumbling unfortunately on the body of one of his ſlain brothers, the ſight of it made him loſe all thoughts about the enemy; and inſtead of purſuing them, he ſpent part of his time in idle lamentations, and part in burying the corpſe with ſuitable pomp and dignity. By this means Beliſarius had an opportunity of rallying his men; which he did ſo effectually, that, coming unexpectedly upon Gilimer, he eaſily gained a new and complete victory over him.

19 takes Carthage; This defeat was followed by the loſs of Carthage, which the barbarians had been at no pains to put into a poſture of defence. After which Gilimer, having in vain endeavoured to obtain aſſiſtance from the Moors and Goths, was obliged to recal his brother Tzaſon from Sardinia. The meeting between the two brothers was very mournful; but they ſoon came to a reſolution of making one deſperate attempt to regain the loſt kingdom, or at leaſt recover their captives out of the hands of the enemy. The conſequence of his reſolution was another engagement, in which Tzaſon was killed with 800 of his choiceſt men, while the Romans loſt no more than 50; after which Beliſarius moving ſuddenly forward at the head of all his army, fell upon the camp of the Vandals. This Gilimer was no ſooner appriſed of, than, without ſtaying to give any more orders to the reſt of his army, he fled towards Numidia in the utmoſt conſternation. His flight was not immediately known among his troops; but when it was, ſuch an univerſal confuſion enſued, that they abandoned their camp to the Romans, who had now nothing to do but plunder it; and not content with this, they maſſacred

20 and puts an end to the Vandalic monarchy. all the men found in it, carrying away the women captives.

Thus a total end was put to the power of the Vandals in Barbary, and the Romans once more became maſters of this country. The Vandal inhabitants were permitted to remain as they were, on condition of exchanging the hereſy of Arius for the orthodox faith. As for Gilimer, he fled with the utmoſt expedition to Medamus, a town ſituated on the top of the Pappuan mountain, and almoſt inacceſſible by reaſon of its height and ruggedneſs. The ſiege of this place was committed to Pharas, an officer of great experience, who having ſhut up all avenues to the town, the un- 21

Gilimer's extreme diſtreſs. happy Gilimer was reduced to the greateſt ſtraits for want of proviſions. Pharas being ſoon apprized of the diſtreſs he was in, wrote him a moſt friendly and pathetic letter, earneſtly exhorting him to put an end to the diſtreſs of himſelf and his friends by a ſurrender. This Gilimer declined; but at the ſame time concluded his anſwer with a moſt ſubmiſſive requeſt, that Pharas would ſo far pity his great diſtreſs as to ſend him a loaf of bread, a ſponge, and a lute. This ſtrange requeſt greatly ſurpriſed Pharas; but at laſt it was explained by the meſſenger, who told him that the king had not taſted any baked bread ſince his arrival on that mountain, and earneſtly longed to eat a morſel of it before he died: the ſponge he wanted to allay a tumour that was fallen on one of his eyes; and the lute, on which he had learned to play, was to aſſiſt him in ſetting ſome elegiac verſes he had compoſed on the ſubject of his misfortunes to a ſuitable tune. At this mournful report Pharas could not reſtrain from tears, and immediately deſpatched the meſſenger with the things he wanted.

Gilimer had ſpent near three winter months on the ſummit of this inhoſpitable mountain, his miſery hardening him ſtill more againſt the thoughts of ſurrendering, when a melancholy ſcene in his own family at once reconciled him to it. This was a bloody ſtruggle between two boys, one of them his ſiſter's ſon, about a flat bit of dough, laid on the coals; which the one ſeized upon, burning hot as it was, and clapped it into his mouth; but the other by dint of blows forced it out, and eat it from him. This quarrel, which might have ended fatally had not Gilimer interpoſed, made ſo deep an impreſſion upon him, that he immediately deſpatched a meſſenger to Pharas, acquainting him that he was willing to ſurrender himſelf and all his effects upon the conditions he had offered, as ſoon as he was aſſured that they were embraced by Beliſarius. Pharas loſt no time to get them ratified and ſent back to him; after which he was conducted to Beliſarius, who gave him a very kind reception. Gilimer was afterwards brought before Juſtinian in gold chains, whom he beſought in the moſt ſubmiſſive manner to ſpare his 22

Kindly treated by Juſtinian. life. This was readily granted by the emperor; who alſo allowed him a handſome yearly penſion to live upon as a private gentleman. But his mind and heart were too much unſettled and broken to enjoy the ſweets of a private ſtate; ſo that Gilimer, oppreſſed with grief, died in the year 534, the firſt of his captivity, and five years after he had been raiſed to the throne.

Barbary being thus again reduced under the power of the Romans, its hiſtory falls to be taken notice of under that of Rome. In the caliphate of Omar, this 23

Barbary ſubdued by the Saracens. country was reduced by the Saracens, as we have already related under the article Arabia. It continued ſubject to the caliphs of Arabia and Bagdad till the reign of Harun Al Raſchid, who having appointed Ibrahim

brahim Ebn Aglab governor of the weſtern parts of his empire, that prefect took the opportunity, firſt of aſſuming greater powers to himſelf than had been granted by the caliph, and then erecting a principality altogether independent of the caliphs. The race of Aglab continued to enjoy their new principality peaceably till the year of the Hegira 297 or 298, during which time they made ſeveral deſcents on the iſland of Sicily, and conquered part of it. About this time, however, one Obeidallah rebelled againſt the houſe of Aglab, and aſſumed the title of caliph of *Kairwan* (the ancient Cyrene, and reſidence of the Aglabite princes). To give the greater weight to his pretenſions he alſo took the ſurname of Al Mohdi, or Al Mahedi, the *director*. According to ſome, alſo, he pretended to be deſcended in a right line from Ali Ebn Abu Taleb, and Fatema the daughter of Mahomet; for which reaſon, ſay they, the Arabs called him and his deſcendants *Fatemites*. He likewiſe encouraged himſelf and his followers by a traditional prophecy of Mahomet, that at the end of 300 years the ſun ſhould riſe out of the weſt. Having at length driven the Aglabites into Egypt, where they became known by the name of *Magrebians*, he extended his dominions in Africa and Sicily, making Kairwan the place of his reſidence.

24 Principal city of the Aglabites founded.

25 Driven out by Al Mohdi the firſt Fatemite caliph.

26 His general Habbaſah invades Egypt.

In the 300th year of the Hegira, Habbaſah, one of Al Mohdi's generals, overthrew the caliph Al Mokhtader's forces in the neighbourhood of Barca, and made himſelf maſter of that city. After which he reduced Alexandria itſelf; and was making great progreſs in the conqueſt of the whole country, when Al-Mokhtader deſpatched againſt him his two generals Takin and Al Kaſem, with an army of 100,000 men. Habbaſah being informed that the caliph's troops were in motion, advanced at the head of his army to give them battle, and at laſt came up with them in an iſland called by the Arabs *Ard Al Khamſin*. Here he attacked them with incredible bravery, notwithſtanding their force was much ſuperior to his; but the approach of night obliged both generals to ſound a retreat.—The action therefore was by no means deciſive, though extremely bloody, the caliph's generals having loſt 20,000, and Habbaſah 10,000. The latter, however, durſt not renew the fight next morning; but ſtole off in the night, and returned home, ſo that Al Mokhtader in effect gained a victory. In the 302d year of the Hegira, however, Habbaſah returned, poſſeſſed himſelf of Alexandria a ſecond time, defeated a body of the caliph's forces, and killed 7000 of them upon the ſpot. What further progreſs he made at that time we are not certainly told; but in the 307th year of the Hegira, Abul Kaſem, ſon to the Fatemite caliph Al Mohdi, again entered Egypt with an army of 100,000 men. At firſt he met with extraordinary ſucceſs, and overran a conſiderable part of that fine country. He made himſelf maſter of Alexandria, Al Tayum, Al Baknaſa, and the iſle of Al Aſhmaryin, penetrating even to Al Jizah, where the caliph's army under the command of Munes was poſted in order to oppoſe him. In this country he found means to maintain himſelf till the 308th year of the Hegira. This year, however, he was entirely defeated by Munes, who made himſelf maſter of all his baggage, as well as of the plunder he had acquired; and this blow obliged him to fly to Kairwan with the ſhattered remains of his army, where he remained without making any further attempt on Egypt.

27 As does alſo his ſon Abul Kaſem,

28 who is utterly defeated by Munes.

Al Mohdi reigned 24 years; and was ſucceeded by his ſon Abul Kaſem above-mentioned, who then took the ſurname *Al Kayem Mohdi*. During his reign we read of nothing remarkable, except the revolt of one Yezid Ebn Condat, a man of mean extraction, but who, having been raiſed to the dignity of chancellor, found means to raiſe ſuch a ſtrong party, that the caliph was obliged to ſhut himſelf up in the caſtle of Mohedia. Yezid, being then at the head of a powerful army, ſoon reduced the capital of Kairwan, the cities of Al Rakkada and Tunis, and ſeveral other fortreſſes. He was no leſs ſucceſsful in defeating a conſiderable number of troops which Al Kayem had raiſed and ſent againſt him; after which he cloſely beſieged the caliph himſelf in the caſtle where he had ſhut himſelf up. The ſiege continued ſeven months; during which time the place was reduced to ſuch ſtraits, that the caliph muſt either have ſurrendered it or been ſtarved, when death put an end to his anxiety in the 12th year of his reign, and 334th of the Hegira.

29 Rebellion of Yezid.

Al Kayem was ſucceeded by his ſon Iſhmael, who immediately took upon himſelf the title of *Al Manſur*. This caliph thought proper to conceal the death of his father till he had made the preparations neceſſary for reducing the rebels. In this he was ſo ſucceſsful that he obliged Yezid to raiſe the ſiege of Mohedia the ſame year; and in the following gave him two great overthrows, obliging him to ſhut himſelf up in the fortreſs of Kothama, or Cutama, where he beſieged him in his turn. Yezid defended the place a long time with deſperate bravery; but finding the garriſon at laſt obliged to capitulate, he made ſhift to eſcape privately. Al Manſur immediately deſpatched a body of forces in purſuit of him; who overtook, and brought him back in fetters; but not till after a vigorous defence, in which Yezid received ſeveral dangerous wounds, of which he died in priſon. After his death, Al Manſur cauſed his body to be flayed, and his ſkin ſtuffed and expoſed to public view. Of Al Manſur's exploits in Sicily an account is given under that article. Nothing farther remarkable happened in his African dominions; and he died after a reign of ſeven years and 16 days, in the 341ſt of the Hegira.

30 Al Manſur caliph.

31 Death of Yezid.

Al Manſur was ſucceeded by his ſon Abu Zammin Moad, who aſſumed the ſurname of *Al Moez Ledinillah*. He proved a very warlike prince, and maintained a bloody conteſt with Abdalrahman, caliph of Andaluſia; for a particular account of which ſee the article Spain. In the 347th year of the Hegira, beginning March 25th, 958, Al Moez ſent a powerful army to the weſtern extremity of Africa, under the command of Abul Haſan Jawhar, one of his ſlaves, whom he had advanced to the dignity of vizir. Jawhar firſt advanced to a city called *Tahart*, which he beſieged for ſome time ineffectually. From thence he marched to Fez, and made proper diſpoſitions for attacking that city. But finding that Ahmed Ebn Becr, the emir of the place, was reſolved to defend it to the laſt, he thought proper to abandon the enterpriſe. However, having traverſed all the tract between that capital and the Atlantic ocean, he again ſat down before Fez, and took it by ſtorm the following year.

32 Al Moez Ledinillah caliph.

But

33 He conquers Egypt,

But the greatest atchievement performed by this caliph was his conquest of Egypt, and the removal of the caliphate to that country. This conquest, though long projected, he did not attempt till the year of the Hegira 358. Having then made all necessary preparations for it, he committed the care of that expedition to a faithful and experienced general called *Giafar*, or *Jaafar;* but in the mean time, this enterprise did not divert Al Moez from the care of his other conquests, particularly those of Sicily and Sardinia: to the last of which he sailed in the year of the Hegira 361, continuing a whole year in it, and leaving the care of his African dominions to an experienced officer named *Yusef Ben Zeiri.* He sailed thence the following year for Tripoli in Barbary, where he had not staid long before he received the agreeable news that his general had made himself master of Alexandria. He lost no time, but immediately embarked for it, leaving the government of his old African dominions in the hands of his trusty servant Yusef above-mentioned, and arriving safely at that port was received with all the demonstrations of joy. Here he began to lay the foundations of his new Egyptian dynasty, which was to put a final end to the old one of Kairwan after it had continued about 65 years.

34 and transfers the seat of government to that country.

Al Moez preserved all his old dominions of Kairwan or Africa Proper. But the ambition or avarice of the governors whom he appointed suffered them to run quickly to a shameful decay; particularly the new and opulent metropolis of Mohedia, on which immense sums had been lavished, as well as labour and care, so as to render it not only one of the richest and stateliest, but one of the strongest, cities in the world: so that we may truly say, the wealth and splendor of this once famed, though short-lived state, took their final leave of it with the departure of the caliph Al Moez, seeing the whole maritime tract from the Egyptian confines to the straits of Gibraltar hath since become the nest of the most odious piratical crew that can be imagined.

Under the article ALGIERS we have given a short account of the erection of a new kingdom in Barbary by Texesien; which, however, is there no farther continued than is necessary for the proper understanding the history of that country. A general history might here be given of the whole country of Barbary; but as that would necessarily occasion repetitions under the articles MOROCCO, TRIPOLI, TUNIS, &c. we must refer to those articles for the historical part, as well as for an account of the climate, inhabitants, &c.

BARBATELLI, BERNARDINO, otherwise called *Pochetti*, a painter of history, fruit, animals, and flowers, was born at Florence in 1542. He was the disciple of Ridolfo Ghirlandaio at Florence; from whose school he went to Rome, and studied there with such uncommon assiduity, that he was frequently so abstracted, and so absolutely engrossed by the objects of his contemplations, as to forget the necessary refreshments of sleep and food. He was excellent for painting every species of animals, fruit, or flowers; and in those subjects not only imitated, but equalled nature. His touch was free, light and delicate, and the colouring of his objects inexpressibly true; and, beside his merit in this most usual style of painting, the historical subjects which he designed from sacred or profane authors were much esteemed and admired. He died in 1612.

BARBE, or BARB. See BARB.

BARBE in the military art. To fire in barbe, means to fire the cannon over the parapet, instead of firing through the embrasures; in which case, the parapet must not be above three feet and a half high.

BARBE, or BARDE, is an old word, denoting the armour of the horses of the ancient knights and soldiers, who were accoutred at all points. It is said to have been an armour of iron and leather, wherewith the neck, breast, and shoulders of the horse were covered.

BARBE, *St*, a town of Biscay in Mexico, near which are rich silver mines. W. Long. 109. 55. N. Lat. 26. 0.

BARBED, in a general sense, bearded like a fish-hook set with barbs; also shaved or trimmed.

Barbed and Crested, in *Heraldry*, an appellation given to the combs and gills of a cock, when particularized for being of a different tincture from the body.

A *barbed cross*, is a cross the extremities whereof are like the barbed irons used for striking fish.

BARBEL, in *Ichthyology*. See CYPRINUS.

BARBELICOTÆ, an ancient sect of Gnostics, spoken of by Theodoret. Their doctrines were absurd, and their ceremonies too abominable to be repeated.

BARBER, one who makes a trade of shaving or trimming the beards of other men for money. Anciently a lute or viol, or some such musical instrument, was part of the furniture of a barber's shop, which was used then to be frequented by persons above the ordinary level of the people, who resorted to the barber either for the cure of wounds, or to undergo some chirurgical operation, or, as it was then called, to be *trimmed*, a word that signified either shaving or cutting and curling the hair; these, together with letting blood, were the ancient occupations of the barber-surgeon. As to the other important branch of surgery, the setting of fractured limbs, that was practised by another class of men called *bone-setters*, of whom there are hardly any now remaining. The musical instruments in his shop were for the entertainment of waiting customers; and answered the end of a newspaper, with which at this day those who wait for their turn at the barber's amuse themselves. For the origin of the barber's *pole*, see the article APPELLATION.

BARBERINI, FRANCIS, one of the most excellent poets of his age, was born at Barberino, in Tuscany, in the year 1264. As his mother was of Florence, he settled in that city; where his profession of the law, but especially the beauty of his poetry, raised him a very considerable character. The greatest part of his works are lost; but that which is entitled the *Precepts of Love*, which is a moral poem calculated in instruct those in their duty who have a regard for glory, virtue, and eternity, has had a better fate. It was published at Rome, adorned with beautiful figures, in 1640, by Frederic Ubaldini; he prefixed the author's life; and, as there are in the poem many words which are grown obsolete, he added a glossary to explain them, which illustrates the sense by the authority of cotemporary poets.

BARBERINO, a town of Tuscany in Italy, situated at the foot of the Apennine mountains, in E. Long. 12. 25. N. Lat. 43. 40.

BARBERRY. See BERBERIS, BOTANY *Index*.

BARBESUL in *Ancient Geography*, a town and river of Bætica, and a colony in the resort of the Conventus Gaditanus in Spain : now *Morbella* in Grenada.

BARBET in *Natural Hiſtory*, a name given by M. Reaumur, and other of the French writers, to a peculiar ſpecies of the worms which feed on the pucerons or aphides. See APHIS, ENTOMOLOGY *Index*.

BARBETS, the name of the inhabitants of ſeveral valleys in Piedmont, particularly thoſe of Lucern, Angrona, Peruſa, and St Martin.

BARBEYRAC, JOHN, was born in Beſiers in Lower Languedoc in 1674. He was made profeſſor of law and hiſtory at Lauſanne in 1710: which he enjoyed for ſeven years, and during that time was three times rector: in 1717, he was profeſſor of public and private law at Groningen, He tranſlated into French the two celebrated works of Puffendorf, his *Law of Nature and Nations*, and his *Duties of a Man and a Citizen ;* to both which he wrote excellent notes, and to the former an introductory preface. He tranſlated alſo Grotius's treatiſe *De Jure Belli ac Pacis*, with large and excellent notes; and ſeveral of Tillotſon's ſermons. He wrote a work entitled *Traité de Jeu*, 2 vols. 8vo.

BARBEZIEUH, a town of Saintonge in France, with the title of a marquiſate. It hath a manufacture of linen cloth; and lies in W. Long. 0. 5. N. Lat. 45. 23.

BARBICAN, or BARBACAN. See BARBACAN.

BARBIERI, GIOVANNI FRANCESCO, otherwiſe called *Guercino da Cento*, an eminent hiſtorical painter, was born at Cento, a village not far from Bologna, in 1590. At firſt he was the diſciple of Benedetto Gennari; but he afterwards ſtudied for ſome time in the ſchool of the Caracci, though he did not adopt the manner of that famous academy. He ſeemed to prefer the ſtyle of Caravaggio to that of Guido or Albano, imagining it impoſſible to imitate nature truly, without the aſſiſtance of ſtrong lights and ſtrong ſhadows; and from that principle, his light was admitted into his painting room from above. In effect, by the oppoſition of his ſtrong lights and ſhadows, he gave ſuch force to his pictures, that few, except thoſe of Caravaggio, can ſtand near them, and not ſeem feeble in their effect: however, that manner is cenſured as not being like nature, becauſe it makes objects appear as if they were ſeen by candle-light, or by the brightneſs of a ſun-beam, which alone can juſtify the deepneſs of his ſhadowing. The principal attention of Guercino ſeems to have been fixed on arriving at perfection in colouring; he ſaw the aſtoniſhing effects produced by the colouring of the celebrated Venetian maſters; and obſerved, that notwithſtanding any imperfections in regard to grace, correctneſs, or elegance, the works of theſe maſters were the objects of univerſal admiration. From which obſervation, he ſeems to have devoted his whole ſtudy to excel in colouring ; as if he were convinced, that few are qualified to diſcern the elevation of thought, which conſtitutes the excellence of a compoſition ; few may be touched with the grandeur or beauty of the deſign, or perhaps have a capacity to examine even the correctneſs of any part of a painting ; and yet every eye, and even every imperfect judge of a picture, may be ſenſibly affected by the force and beauty of the colouring. His taſte of deſign was natural, eaſy, and often grand, but without any extraordinary ſhare of elevation, correctneſs, or elegance. The airs of his heads often want dignity, and his local colours want truth. However, there is great union and harmony in his colours, although his carnations are not very freſh ; and in all his works there is a porwerful and expreſſive imitation of life, which will for ever render them eſtimable. Towards the decline of his life, he obſerved that the clearer and brighter ſtyle of Guido and Albano had attracted the admiration of all Europe; and therefore he altered his manner, even againſt his own judgment. But he apologized for that conduct, by declaring, that in his former time he painted for fame, and to pleaſe the judicious; and he now painted to pleaſe the ignorant, and enrich himſelf. He died in 1666.—The moſt capital performance of Guercino, is the hiſtory of S. Petronilla, which is conſidered as one of the ornaments of St Peter's at Rome.

BARBIERI, *Paolo Antonio*, da Cento, painter of ſtill life and animals, was the brother of Guercino, and born at Cento in 1596. He choſe for his ſubjects fruit, flowers, inſects, and animals ; which he painted after nature with a lively tint of colour, great tenderneſs of pencil, and a ſtrong character of truth and life. He died in 1640.

BARBITOS, or BARBITON, an ancient inſtrument of muſic, mounted with three, others ſay ſeven, ſtrings; much uſed by Sappho and Alcæus, whence it is alſo denominated *Leſboum*.

BARBLES, or BARBS, in *Farriery*, the knots or ſuperfluous fleſh that grow up in the channels of a horſe's mouth ; that is, in the intervals that ſeparate the bars, and lie under the tongue. Theſe, which are alſo called *barbes*, obtain in black cattle as well as horſes, and obſtruct their eating. For the cure, they caſt the beaſt, take out his tongue, and clip off the barbles with a pair of ſciſſars, or cut them with a ſharp knife ; others chooſe to burn them off with a hot iron.

BARBOUR, JOHN, archdeacon of Aberdeen, was eſteemed an excellent poet in the reign of David I. He wrote the hiſtory of Robert the Bruce, in an heroic poem, which is ſtill extant, and which contains many facts and anecdotes omitted by other hiſtorians. The lateſt edition of this book is that of Glaſgow, 8vo. printed in the year 1672. It is entitled, "The acts and life of the moſt victorious conqueror Robert Bruce king of Scotland ; wherein alſo are contained the martial deeds of the valiant princes Edward Bruce, Sir James Dowglaſs, Earl Thomas Randel, Walter Steward, and ſundry others." In one paſſage, he calls it a *romance ;* but that word was then of good reputation : every body knows that the 'Romant of romants' has been innocently applied to true hiſtory, as well as the 'Ballad of ballads' to a ſacred ſong.

BARBUDA, one of the Britiſh Caribbee iſlands, about 20 miles long and 12 broad. It is low land, but fruitful and pretty populous. The inhabitants employ themſelves in huſbandry, and find always a ready market for their corn and cattle in the ſugar iſlands. Barbuda is the property of the Codrington family, who have

have great numbers of negroes here as well as in Barbadoes. It lies in W. Long. 61. 3. N. Lat. 18. 5.

BARCA, a large country of Africa, lying on the coast of the Mediterranean fea, between the kingdoms of Egypt and Tripoli, extending itfelf in length from eaft to weft from the 39th to the 46th degree of eaft longitude, and in breadth from north to fouth about 30 leagues, as is generally fuppofed. It is for the moft part, efpecially in the middle, a dry fandy defert: on which account the Arabs call it *Sahart*, or *Ceyart Barka*, that is, the defert or road of whirlwinds or hurricanes. It labours almoft everywhere under a great fcarcity of water; and except in the neighbourhood of towns and villages, where the ground produces fome fmall quantities of grain, fuch as millet and fome maize, the reft is in a manner quite barren and uncultivated, or, to fpeak more properly, uncultivable: and even of that fmall quantity which thofe few fpots produce, the poor inhabitants are obliged to exchange fome part with their indigent neighbours, for dates, fheep, and camels, which they ftand in greater need of than they, by reafon of their great fcarcity of grafs and other proper food; for want of which, thofe that are brought to them feldom thrive or live long. In this country ftood the famed temple of Jupiter Ammon; and notwithftanding the pleafantnefs of the fpot where it ftood, this part of the country is faid to have been the moft dangerous of any, being furrounded with fuch quick and burning fands as are very detrimental to travellers; not only as they fink under their feet, but being light, and heated by the rays of the fun, are eafily raifed by every breath of wind; which, if it chance to be in their faces, almoft burns their eyes out, and ftifles them for want of breath; or if vehement, often overwhelms whole caravans. Againft this temple Cambyfes king of Perfia defpatched an army of 50,000 men. They fet out from Thebes in Upper Egypt, and under the conduct of proper guides reached the city of Oafis feven days journey from that place: but what was their fate afterwards is uncertain; for they never returned either to Egypt or to their own country. The Ammonians informed Herodotus, that, after the army had entered the fandy defert which lies beyond Oafis, a violent wind began to blow from the fouth at the time of their dinner, and raifed the fand to fuch a degree, that the whole army was overwhelmed and buried alive.

Concerning the government or commerce of this country we know nothing certain. Moft probably the maritime towns are under the protection of the Porte: but whether under the bafhaw of Egypt or Tripoli, or whether they have formed themfelves into independent ftates like thofe of Algiers and Tunis, we cannot fay; only we are told that the inhabitants of the maritime towns are more civilized than thofe that dwell in the inland parts. The firft profefs Mahometanifm, and have imbibed fome notions of humanity and juftice; whilft the latter, who have neither religion nor any fign of worfhip among them, are altogether favage and brutifh. They are a fort of Arabs, and like them live entirely upon theft and plunder. By them this tract, which before was a continued defert, was firft inhabited. At their firft coming in, they fettled themfelves in one of the beft places of the country; but as they multiplied, and had frequent wars with one another, the

ftrongeft drove the weakeft out of the beft fpots, and fent them to wander in the defert parts, where they live in the moft miferable manner, their country hardly affording one fingle neceffary of life. Hence it is that they are faid to be the ugIieft of all the Arabs: their bodies having fcarcely any thing but fkin and bone, their faces meagre, with fierce ravenous looks; their garb, which is commonly what they take from the paffengers who go through thefe parts, tattered with long wearing; while the pooreft of them have fcarce a rag to cover their nakednefs. They are moft expert and refolute robbers, that being their chief employment and livelihood; but the travellers in thefe parts are fo few, that the Barcans are often neceffitated to make diftant excurfions into Numidia, Libya, and other fouthern countries. Thofe that fall into their hands are made to drink plenty of warm milk: then they hang them up by the feet, and fhake them, in order to make them vomit up any money they think they have fwallowed; after which, they ftrip them of all their clothes, even to the laft rag: but with all this inhumanity, they commonly fpare their life, which is more than the other African robbers do. Yet notwithftanding every artifice they can ufe, the Barcans are fo poor, that they commonly let, pledge, or even fell, their children to the Sicilians and others from whom they have their corn, efpecially before they fet out on any long excurfion.

BARCALON, an appellation given to the prime minifter of the king of Siam. The barcalon has in his department every thing relating to commerce, both at home and abroad. He is likewife fuperintendant of the king's magazines.

BARCELONA, a handfome, rich, and ftrong city of Spain, in the province of Catalonia, of which it is the capital. This city was originally founded by Hamilcar Barcas, and from him called *Barcino*. It was reduced by the Romans, and continued fubject to them till the kingdom of Spain was overrun by the Goths and Vandals, and afterwards by the Saracens or Moors. In the beginning of the 9th century, Barcelona was in the hands of the Moors, and under the government of one *Zade*. This governor having more than once abufed the clemency of Charlemagne, at laft irritated Lewis king of Aquitain, and fon to Charles, to fuch a degree, that he gave orders to his generals to inveft the city, and not to rife from before it till they had put Zade into his hands. The Moor made a moft obftinate refiftance, fo that the fiege lafted many months: at laft, finding it impoffible to preferve the city much longer, and being deftitute of all hopes of relief, he determined, or rather was compelled by the inhabitants, to go to the Chriftian camp and implore the emperor's mercy; but here he was no fooner arrived than he was arrefted and fent prifoner to Charlemagne, who condemned him to perpetual banifhment. The people gaining nothing by this expedient, continued to hold out for fix weeks longer, when the king of Aquitain himfelf took the command of the fiege. To him they made a propofal, that if he would allow them to march out and go where they pleafed, they would furrender the place. Lewis having agreed to this, made his public entry into Barcelona, where he formed a defign of extending his father's dominions as far as the Ebro; but being recalled before he could put his defign in execution, he he appointed one Bera count of Barcelona. The city continued ſubject to him and his ſucceſſors, who ſtill enjoyed the title of *counts of Barcelona*, from the year 802 to 1131; during which time we find nothing remarkable, except that the city was once taken by the Moors, but ſoon after retaken by the aſſiſtance of Lewis IV. king of France. In 1131 it was united to the crown of Arragon by the marriage of Don Raymond V. count of Barcelona with the daughter of Don Ramiro the monk, king of Arragon. In 1465 the Catalonians revolted againſt Don Juan II. king of Arragon, out of hatred to his queen Donna Juanna; the conſequence of which was, that Barcelona was beſieged by that monarch in 1471. Various efforts were made by Lewis XI. of France and the duke of Lorrain in order to raiſe the ſiege, but without effect. Things at length were brought to the utmoſt extremity, when the king offered to pardon them all, without the ſmalleſt puniſhment either in perſon or property, provided they would ſubmit: but theſe terms they rejected, chiefly through the influence of the Count de Pailhars, who had been pardoned the year before. The army, on the other hand, was very earneſt on being led on to the aſſault, in hopes of plunder. The king, however, wrote a letter to the citizens, dated the 6th of October, in terms as affectionate as if he had been writing to his children, bewailing the miſeries they had brought on themſelves, and concluding with a proteſtation that they, and not he, muſt be anſwerable for the conſequences. Upon this, at the perſuaſion of a prieſt who had a reputation for ſanctity, they ſent deputies to the king, and made a capitulation on the 17th of the ſame month. In this the king acknowledged they had taken up arms on juſt motives; and forgave every body except Pailhars, who was, however, ſuffered to eſcape. On the 22d of October the king made his entry into the city, and confirmed all their ancient privileges. In 1697, Barcelona was taken by the French, after a bloody ſiege of 52 days; and the loſs of this city had a conſiderable effect in diſpoſing the Spaniards to agree to the treaty of Ryſwick. In Queen Anne's time it was taken by the allies under the earl of Peterborough; but being afterwards ſhamefully denied aſſiſtance by the Engliſh miniſtry, was obliged to ſubmit to Philip II. by whom the whole province was deprived of its ancient privileges; for a particular account of which, ſee the article Spain.

Barcelona is ſituated by the ſea-ſide, of a form between a ſquare and an oval. It is ſurrounded with a good brick wall, round which is another, with 14 baſtions, horn-works, ramparts, and ditches; the ramparts are high, broad, and ſpacious, inſomuch that 100 coaches may be ſeen every evening driving thereon for pleaſure. The city is divided into two parts, the Old and the New, which are ſeparated from each other by a wall and a large ditch; the ſtreets are handſome, well paved with large ſtones, wide, and very clean. It is the reſidence of a viceroy, is a biſhop's ſee, has a fine univerſity, a mint, a good port, and is adorned with handſome buildings. Here is a court of inquiſition, which the inhabitants look upon as an advantage. The remarkable buildings are the cathedral, which is large, handſome, and adorned with two high towers, the church of the Virgin Mary, the palace of the biſhop, that of the inquiſition, and ſeveral religious houſes: add to theſe the palace of the viceroy; the arſenal, which contains arms for 1000 men; the exchange, where the merchants meet; the terſana, where they build the galleys; and the palace where the nobility of the country meet, called *La Caſa de la Deputation*. This laſt is built with fine large freeſtone, and adorned with columns of marble: there is in it a large hall, with a gilt cieling and a handſome portico, wherein perſons may either walk or ſit; the hall is adorned with the portraits of all the counts of Barcelona. There are ſeveral fine ſquares, particularly that of St Michael, into which all the great ſtreets run. The port is wide, ſpacious, deep, and ſafe; defended on the one ſide by a great mole, and on the other ſheltered from the weſt wind by two mountains that advance into the ſea, and form a kind of promontory: the mole is 750 paces long, with a quay, at the end of which is a light-houſe and a ſmall fort. One of the mountains, called *Mount Joy*, is very high, and riſes in the middle of the plain near the city: it is covered with gardens, vineyards, groves of trees, and has a ſtrong fort for the defence of the city. This mountain, being a rock, yields an inexhauſtible quarry of fine hard freeſtone. Barcelona is a place of great trade, on account of the conveniency of its harbour; and it has a manufacture of knives greatly eſteemed in Spain, as alſo of blankets. Here are alſo ſeveral glaſs-houſes. The inhabitants are diligent, and equally fit for labour and trade; they are alſo very civil to ſtrangers. The women are well ſhaped, and as handſome as any in Spain; they are briſk and lively in their converſation, and more free and unreſtrained in their behaviour than in other parts of Spain. E. Long. 2. 5. N. Lat. 41. 26.

BARCELONETTA, a town of France, in the department of the Lower Alps, formerly in the government of Dauphiny, and capital of the valley of its own name. It belonged to the duke of Savoy, and was ceded to France by the treaty of Utrecht in 1712. E. Long. 6. 40. N. Lat. 44. 26.

BARCELOR, a town of Aſia, in the Eaſt Indies, on the coaſt of Malabar. It is a Dutch factory, where they carry on a conſiderable trade in pepper. E. Long. 74. 15. N. Lat. 13. 45.

BARCELOS, a town of Portugal, with the title of a duchy. It is ſeated on the river Cavado, over which there is a handſome bridge. W. Long. 7. 0. N. Lat. 41. 20.

BARCINO in *Ancient Geography*, a town of the Terraconenſis in Spain, and capital of the Laletani. Now Barcelona. See that article.

BARCLAY, Alexander, a learned monk in the reign of Henry VIII. Where he was born, though of no great importance, was nevertheleſs a matter of virulent contention among his former biographers. Bale, who was his cotemporary, is of opinion he was born in Somerſetſhire. There is indeed a village of his name, and a numerous family, in that county. Pits thinks he was born in Devonſhire. Mackenzie is poſitive he was a Scotchman; but without proof, unleſs we admit as ſuch his name *Alexander*. He was, however, educated in Oriel-college Oxford. After leaving the univerſity he went abroad, and continued ſome time in France, Italy, and Germany, where he acquired a competent knowledge of the languages of thoſe countries, as appears from ſeveral tranſlations of books,

which

Barclay. which he afterwards published. On his return to England, he was made chaplain to his patron the bishop of Tyne, who likewise appointed him a priest of St Mary, at the college of Ottery in Devonshire, founded by Grandison bishop of Exeter. After the death of his patron, he became a Benedictine monk of Ely. On the dissolution of that monastery, he first obtained the vicarage of St Matthew at Wokey in Somersetshire; and, in 1549, being then doctor of divinity, was presented to the vicarage of Much Badew in Essex. In 1552, he was appointed rector of Allhallows, Lombard-street, which he lived to enjoy but a very short time. He died at Croydon in Surrey in June 1552. He is generally allowed to have improved the English language, and to have been one of the politest writers of his time. He composed several original works; but was chiefly remarkable for his translations from the Latin, Italian, French, and German languages. His version from Sallust of the war of Jugurtha is accurate, and not without elegance. His lives of several saints, in heroic verse, are still unpublished. His *Stultifera navis*, or *The ship of fools*, is the most singular of his performances. It was printed by Richard Pynson at London, 1509, in folio; and contains a variety of wooden plates, which are worthy the inspection of the curious.

Barclay, *William*, a learned civilian, was born in Aberdeenshire in the year 1541. He spent the early part of his life, and much of his fortune, at the court of Mary queen of Scots, from whose favour he had reason to expect preferment. In 1573 he went over to France, and at Bourges commenced student of civil law under the famous Cujacius. He continued some years in that seminary, where he took a doctor's degree; and was soon after appointed professor of civil law in the university of Pont-à-Mousson, then first founded by the duke of Lorrain. That prince afterwards made him counsellor of state and master of requests. Barclay, in the year 1581, married Ann de Mallaville, a French lady, by whom he had a son, who became a celebrated author, and of whom the reader will find an account in the next article. This youth the Jesuits would gladly have received into their society. His father refused his consent, and for that reason these disciples of Jesus soon contrived to ruin him with the duke his patron. Barclay now embarked for Britain, where King James I. offered him considerable preferment, provided he would become a member of the church of England: but not choosing to comply, he returned to France in 1604; and, soon after his arrival, was apppointed professor of civil law in the university of Angers, where he died the year following, and was buried in the Franciscan church. He was esteemed a learned civilian; and wrote elaborately in defence of the divine right of kings, in answer to Buchanan and others. The titles of his works are, 1. *De regno et regali potestate*, &c. 2. *Commentarius in tit. pandectarum de rebus creditis, et de jurejurando.* 3. *De potestate papæ*, &c. 4. *Primitia in vitam Agricolæ.*

Barclay, *John*, son of the former, was, as we have above mentioned, so great a favourite of the Jesuits, that they used all their efforts to engage him in their society. His father would not consent, and carried his son with him into England, who was already an author, for he had published "A Commentary upon the Thebais of Statius," and a Latin poem on the coronation of King James, and the first part of *Euphormio*, 1603. He returned to France with his father; and after his father's death went to Paris, and soon after came back to London: he was there in 1606. He published "The History of the Gunpowder Plot," a pamphlet of six leaves, printed at Amsterdam. He published at London in 1610 "An Apology for the Euphormio," and his father's treatise *De potestate papæ*. And at Paris, 1612, he published a book entitled *Pietas*, in answer to Cardinal Bellarmin, who had written against William Barclay's book concerning the power of the Pope. Two years after he published *Icon Animorum.* He was invited to Rome by Pope Paul V. and received a great deal of civility from Cardinal Bellarmin, though he had written against him. He died at Rome in 1621, while his *Argenis* was printing at Paris. This celebrated work has since gone through a great number of editions, and has been translated into most languages. M. de Peiresc, who had the care of the first edition, caused the effigies of the author to be placed before the book; and the following distich, written by Grotius, was put under it:

Gente Caledonius, Gallus natalibus, hic est,
Romam Romano qui docet ore loqui.

Barclay, *Robert*, one of the most eminent among the Quakers, the son of Colonel David Barclay, descended of the ancient family of Barclays, was born at Edinburgh in 1648. He was educated under an uncle at Paris, where the Papists used all their efforts to draw him over to their religion. He joined the Quakers in 1669, and distinguished himself by his zeal and abilities in defence of their doctrines. In 1676 he published in Latin at Amsterdam his "Apology for the Quakers;" which is the most celebrated of his works, and esteemed the standard of the doctrine of the Quakers. The *Theses Theologicæ*, which were the foundation of this work, and addressed to the clergy of what sort soever, were published before the writing of the *Apology*, and printed in Latin, French, High-Dutch, Low-Dutch, and English. The dedication of his *Apology* to King Charles II. is very remarkable for the uncommon frankness and simplicity with which it is written. Amongst many other extraordinary passages, we meet with the following: "There is no king in the world who can so experimentally testify of God's providence and goodness; neither is there any who rules so many free people, so many true Christians; which thing renders thy government more honourable, thyself more considerable, than the accession of many nations filled with slavish and superstitious souls. Thou hast tasted of prosperity and adversity; thou knowest what it is to be banished thy native country, to be over-ruled as well as to rule and sit upon the throne; and being oppressed, thou hast reason to know how hateful the oppressor is both to God and man: if, after all those warnings and advertisements, thou dost not turn unto the Lord with all thy heart, but forget him who remembered thee in thy distress, and give thyself up to follow lust and vanity, surely great will be thy condemnation."—He travelled with the famous Mr William Penn through the greatest part of England,

 Holland,

Barcochebas, Bard.

Holland, and Germany, and was everywhere received with the higheſt reſpect; for though both his converſation and behaviour were ſuitable to his principles, yet there was ſuch livelineſs and ſpirit in his diſcourſe, and ſuch ſerenity and cheerfulneſs in his deportment, as rendered him extremely agreeable to all ſorts of people. When he returned to his native country he ſpent the remainder of his life in a quiet and retired manner. He died at his own houſe at Ury on the 3d of October 1690, in the 42d year of his age.

BARCOCHEBAS, or rather BARCOCHAB, a Jewiſh impoſtor, whoſe real name was *Akiba;* but he took that of *Barcochab*, which ſignifies the *Son of a Star;* in alluſion to the prophecy of Balaam, "There ſhall a ſtar ariſe out of Jacob." He proclaimed himſelf the Meſſiah; and talking of nothing but wars, victories, and triumphs, made his countrymen riſe againſt the Romans, by which means he was the author of innumerable diſorders: he ravaged many places, took a great number of fortreſſes, and maſſacred an infinite multitude of people, particularly the Chriſtians. The emperor ſent troops to Rufus, governor of Judea, to ſuppreſs the ſedition. Rufus, in obedience, exerciſed a thouſand cruelties, but could not finiſh his attempt. The emperor was therefore obliged to ſend Julius Severus, the greateſt general of that time; who attained his end without a direct battle: he fell on them ſeparately; cut off their proviſions; and at laſt the whole conteſt was reduced to the ſiege of Bitter, in the 18th year of Hadrian. The impoſtor periſhed there. This war coſt the Romans a great deal of blood.

BARD, a word denoting one who was a poet by his genius and profeſſion; and "who ſung of the battles of heroes, or the heaving breaſts of love." *Oſſian's Poems*, I. 37.

The curioſity of man is great with reſpect to the tranſactions of his own ſpecies; and when ſuch tranſactions are deſcribed in verſe, accompanied with muſic, the performance is enchanting. An ear, a voice, ſkill in inſtrumental muſic, and, above all, a poetical genius, are requiſite to excel in that complicated art. As ſuch talents are rare, the few that poſſeſſed them were highly eſteemed; and hence the profeſſion of a bard, which, beſide natural talents, required more culture and exerciſe than any other known art. Bards were capital perſons at every feſtival and at every ſolemnity. Their ſongs, which, by recording the achievements of kings and heroes, animated every hearer, muſt have been the entertainment of every warlike nation. We have Heſiod's authority, that in his time bards were as common as potters or joiners, and as liable to envy. Demodocus is mentioned by Homer as a celebrated bard; and Phemius, another bard, is introduced by him deprecating the wrath of Ulyſſes in the following words:

Kaimes's Sketches, Sk. v. ſect. ii.

"O King! to mercy be thy ſoul inclin'd,
"And ſpare the poet's ever-gentle kind:
"A deed like this thy future fame would wrong,
"For dear to gods and men is ſacred ſong.
"Self-taught I ſing; by heav'n, and heav'n alone,
"The genuine ſeeds of poeſy are ſown;
"And (what the gods beſtow) the lofty lay,
"To gods alone, and godlike worth, we pay.
"Save then the poet, and thyſelf reward;
"'Tis thine to merit, mine is to record."

Odyſſey, viii.

Cicero reports, that at Roman feſtivals, anciently, the virtues and exploits of their great men were ſung. The ſame cuſtom prevailed in Peru and Mexico, as we learn from Garcilaſſo and other authors. We have for our authority Father Gobien, that even the inhabitants of the Marian iſlands have bards, who are greatly admired, becauſe in their ſongs are celebrated the feats of their anceſtors.

But in no part of the world did the profeſſion of bard appear with ſuch luſtre as in Gaul, in Britain, and in Ireland. Wherever the Celtæ or Gauls are mentioned by ancient writers, we ſeldom fail to hear of their druids and their bards; the inſtitution of which two orders, was the capital diſtinction of their manners and policy. The druids were their philoſophers and prieſts; the bards, their poets and recorders of heroic actions: and both theſe orders of men ſeem to have ſubſiſted among them, as chief members of the ſtate, from time immemorial. The Celtæ poſſeſſed, from very remote ages, a formed ſyſtem of diſcipline and manners, which appears to have had a deep and laſting influence. Ammianus Marcellinus * gives them this expreſs teſtimony, that there flouriſhed among them the ſtudy of the moſt laudable arts; introduced by the bards, whoſe office it was to ſing in heroic verſe the gallant actions of illuſtrious men; and by the druids, who lived together in colleges or ſocieties, after the Pythagorean manner, and philoſophizing upon the higheſt ſubjects, aſſerted the immortality of the human ſoul. Though Julius Cæſar, in his account of Gaul, does not expreſsly mention the bards; yet it is plain, that, under the title of *Druids*, he comprehends that whole college or order; of which the bards, who, it is probable, were the diſciples of the druids, undoubtedly made a part. It deſerves remark, that, according to his account, the druidical inſtitution firſt took riſe in Britain, and paſſed from thence into Gaul; ſo that they who aſpired to be thorough maſters of that learning were wont to reſort to Britain. He adds too, that ſuch as were to be initiated among the druids, were obliged to commit to their memory a great number of verſes, inſomuch that ſome employed 20 years in this courſe of education; and that they did not think it lawful to record theſe poems in writing, but ſacredly handed them down by tradition from race to race.

Blair's Diſſertation, ſubjoined to *Oſſian's Poems*, vol. ii. p. 306.

* Lib. xv. c. 9.

De Bel. Gal. l. 6.

So ſtrong was the attachment of the Celtic nations to their poetry and their bards, that amidſt all the changes of their government and manners, even long after the order of the druids was extinct, and the national religion altered, the bards continued to flouriſh; not as a ſet of ſtrolling ſongſters, like the Greek Ἀοιδοὶ or *rhapſodiſts*, in Homer's time, but as an order of men highly reſpected in the ſtate, and ſupported by a public eſtabliſhment. We find them, according to the teſtimonies of Strabo and Diodorus, before the age of Auguſtus Cæſar; and we find them remaining under the ſame name, and exerciſing the ſame functions as of old, in Ireland, and in the north of Scotland, almoſt down to our own times. It is well known, that, in both

Bard.

both thefe countries, every *regulus* or chief had his own bard, who was confidered as an officer of rank in his court.

Of the honour in which the bards were held, many inftances occur in Offian's poems. On all important occafions, they were the ambaffadors between contending chiefs; and their perfons were held facred. "Cairbor feared to ftretch his fword to the bards, though his foul was dark. Loofe the bards (faid his brother Cathmor), they are the fons of other times. Their voice fhall be heard in other ages, when the kings of Temora have failed."—The bards, as well as the druids, were exempted from taxes and military fervices, even in times of the greateft danger; and when they attended their patrons in the field, to record and celebrate their great actions, they had a guard affigned them for their protection. At all feftivals and public affemblies they were feated near the perfon of the king or chieftain, and fometimes even above the greateft nobility and chief officers of the court. Nor was the profeffion of the bards lefs lucrative than it was honourable. For, befides the valuable prefents which they occafionally received from their patrons when they gave them uncommon pleafure by their performances, they had eftates in land allotted for their fupport. Nay, fo great was the veneration which the princes of thefe times entertained for the perfons of their poets, and fo highly were they charmed and delighted with their tuneful ftrains, that they fometimes pardoned even their capital crimes for a fong.

Offian, II. 22.

Henry's Hiftory, vol. i. p. 365.

We may very reafonably fuppofe, that a profeffion that was at once fo honourable and advantageous, and enjoyed fo many flattering diftinctions and defirable immunities, would not be deferted. It was indeed very much crowded; and the accounts which we have of the numbers of the bards in fome countries, particularly in Ireland, are hardly credible. We often read, in the poems of Offian, of a hundred bards belonging to one prince, finging and playing in concert for his entertainment. Every chief bard, who was called *Allah Redan*, or *doctor in poetry*, was allowed to have 30 bards of inferior note conftantly about his perfon; and every bard of the fecond rank was allowed a retinue of 15 poetical difciples.

Though the ancient Britons of the fouthern parts of this ifland had originally the fame tafte and genius for poetry with thofe of the north, yet none of their poetical compofitions of this period have been preferved. Nor have we any reafon to be furprifed at this. For after the provincial Britons had fubmitted quietly to the Roman government, yielded up their arms, and had loft their free and martial fpirit, they could take little pleafure in hearing or repeating the fongs of their bards in honour of the glorious achievements of their brave anceftors. The Romans too, if they did not practife the fame barbarous policy which was long after practifed by Edward I. of putting the bards to death, would at leaft difcourage them, and difcountenance the repetition of their poems, for very obvious reafons. The fons of the fong being thus perfecuted by their conquerors, and neglected by their countrymen, either abandoned their country or their profeffion; and their fongs being no longer heard, were foon forgotten.

It is probable that the ancient Britons, as well as many other nations of antiquity, had no idea of poems that were made only to be repeated, and not to be fung to the found of mufical inftruments. In the firft ftages of fociety in all countries, the two fifter-arts of poetry and mufic feem to have been always united; every poet was a mufician, and fung his own verfes to the found of fome mufical inftrument. This, we are directly told by two writers of undoubted credit, was the cafe in Gaul, and confequently in Britain, in this period. "The bards (fays Diodorus Siculus*) fung their poems to the found of an inftrument not unlike a lyre." "The bards (according to Ammianus Marcellinus †, as above hinted) celebrated the brave actions of illuftrious men, in heroic poems, which they fung to the fweet founds of the lyre." This account of thefe Greek and Latin writers is confirmed by the general ftrain, and by many particular paffages, of the poems of Offian. "Beneath his own tree, at intervals, each bard fat down with his harp. They raifed the fong, and touched the ftring, each to the chief he loved ‡."

* Lib. v. fect. 31.

† Lib. xv. c. 9.

‡ Vol. ii. p. 112, 113.

The invention of writing made a confiderable change in the bard profeffion. It is now an agreed point, that no poetry is fit to be accompanied with mufic, but what is fimple: a complicated thought or defcription requires the utmoft attention, and leaves none for the mufic; or, if it divide the attention, it makes but a faint impreffion §. The fimple operas of Quinault bear away the palm from every thing of the kind compofed by Boileau or Racine. But when a language, in its progrefs to maturity, is enriched with variety of phrafes fit to exprefs the moft elevated thoughts, men of genius afpired to the higher ftrains of poetry, leaving mufic and fong to the bards: which diftinguifhed the profeffion of a poet from that of a bard. Homer, in a lax fenfe, may be termed a bard; for in that character he ftrolled from feaft to feaft. But he was not a bard in the original fenfe: he, indeed, recited his poems to crowded audiences; but his poems are too complex for mufic, and he probably did not fing them, nor accompany them with the lyre. The Trovadores of Provence were bards in the original fenfe, and made a capital figure in the days of ignorance, when few could read, and fewer write. In later times, the fongs of the bards were taken down in writing, which gave every one accefs to them without a bard; and the profeffion funk by degrees into oblivion. Among the Highlanders of Scotland, reading and writing in their own tongue is not common even at prefent; and that circumftance fupported long the bard profeffion among them, after being forgot among the neighbouring nations.

Kaimes's Sketches, ubi fupra.

§ See the article *Attention*.

BARDANA, or Burdock. See Arctium, Botany *Index*.

BARDARIOTÆ, in *Antiquity*, were a kind of ancient guard attending the Greek emperors, armed with rods, wherewith they kept off the people from crowding too near the prince when on horfeback. Their captain, or commander, was denominated *primivergius*.—The word was probably formed from the *bardæ*, or houfings on their horfes.

BARDAS, the brother of the emprefs Theodora, and uncle of the famous Photius, is faid to have had no other good quality befides that of loving the fciences and polite literature, which he eftablifhed in the Eaftern

Eaſtern empire; for he was treacherous, cruel, and ambitious. In the year 856, he aſſaſſinated Theoctiſtes, general of the emperor Michael's forces, and obtained his poſt. At length he cauſed the diſgrace of the empreſs Theodora; and St Ignatius, patriarch of Conſtantinople, reproaching him for his vices, he had him depoſed in 858, in order to make room for Photius. Bardas was aſſaſſinated by Baſilius the Macedonian, in 866.

BARDED, in *Heraldry*, is uſed in ſpeaking of a horſe that is capariſoned. He bears ſable, a *cavalier d'or*, the horſe *barded*, argent.

BARDESANISTS, a ſect of ancient heretics, thus denominated from their leader Bardeſanes, a Syrian of Edeſſa in Meſopotamia. Bardeſanes, born in the middle of the ſecond century, became eminent, after his converſion to Chriſtianity, for his zeal againſt heretics; againſt whom, we are informed by St Jerome and Euſebius, he wrote a multitude of books: yet had he the misfortune to fall, himſelf, into the errors of Valentinus, to which he added ſome others of his own. He taught, that the actions of men depend altogether on fate, and that God himſelf is ſubject to neceſſity. His followers went further, and denied the reſurrection of the body, and the incarnation and death of our Saviour; holding that theſe were only apparent or phantaſtical.

BARDEWICK, a town of Germany, in the circle of Lower Saxony and duchy of Lunenburg; formerly a very large place; but being ruined in 1189, by the duke of Saxony, has never yet recovered itſelf. It is ſeated on the river Ilmenau, in E. Long. 10. 6. N. Lat. 53. 40.

BARDT, a ſtrong and rich town of Germany, in the duchy of Pomerania, with a caſtle and ſpacious harbour. It is ſubject to the Swedes; and is ſituated near the Baltic ſea, in E. Long. 13. 20. N. Lat. 54. 23.

BARE, in a general ſenſe, ſignifies *not covered.* Hence we ſay bare-headed, bare-footed, &c.

The Roman women, in times of public diſtreſs and mourning, went *bare-headed*, with their hair looſe.—Among both Greeks, Romans, and Barbarians, we find a feaſt called *Nudipedalia.*—The Abyſſinians never enter their churches, nor the palaces of kings and great men, but *bare-footed.*

Bare-Foot Carmelites and Auguſtines, are religious of the order of St Carmel and St Auſtin, who live under a ſtrict obſervance, and go without ſhoes, like the capuchins. There are alſo bare-foot fathers of mercy. Formerly there were bare-foot dominicans, and even bare-foot nuns of the order of St Auguſtin.

BAREITH, a town of Germany in Franconia, in the margravate of Culembach, with a famous college belonging to the margrave of Brandenburg Bareith. E. Long. 11. 50. N. Lat. 50. 0.

BARENT, Diteric, an excellent painter, was born at Amſterdam, and was the ſon of a very induſtrious painter. He ſtudied in Italy, and became the favourite diſciple of Titian, with whom he lived a long time; but at length returned to Amſterdam, where he painted many extraordinary pieces. He died in 1582, aged 48.

BARFLEUR, a town of France, in Normandy, now the department of the Channel. It was ruined, and had its harbour filled up by the Engliſh in 1346. The cape of that name is 12 miles eaſt of Cherburg, and near it part of the French fleet was deſtroyed in 1692. W. Long. 1. 6. N. Lat. 49. 40.

BARGAIN and Sale a ſpecies of conveyance in the Engliſh law. It is a kind of a real contract, whereby the bargainer for ſome pecuniary conſideration bargains and ſells, that is, contracts to convey, the land of the bargainee; and becomes by ſuch bargain a truſtee for, or ſeized to the uſe of, the bargainee; and then the ſtatute of uſes completes the purchaſe: or, as it hath been well expreſſed, the bargain firſt veſts the uſe, and then the ſtatute veſts the poſſeſſion. But as it was foreſeen that conveyances, thus made, would want all thoſe benefits of notoriety which the old common-law aſſurances were calculated to give; to prevent therefore clandeſtine conveyances of freeholds, it was enacted in the ſame ſeſſion of parliament by ſtatute 27 Hen. VIII. c. 16. that ſuch bargains and ſales ſhould not enure to paſs a freehold, unleſs the ſame be made by indenture, and enrolled within ſix months in one of the courts of Weſtminſter-hall, or with the *cuſtos rotulorum* of the county. Clandeſtine bargains and ſales of chattel intereſts, or leaſes for years, were thought not worth regarding, as ſuch intereſts were very precarious till about ſix years before; which alſo occaſioned them to be overlooked in framing the ſtatute of uſes: and therefore ſuch bargains and ſales are not directed to be enrolled. But how impoſſible is it to foreſee, and provide againſt, all the conſequences of innovations! This omiſſion has given riſe to the ſpecies of conveyance by lease and release.

BARGE (*bargie*, Dutch), a veſſel or boat of ſtate, furniſhed with elegant apartments, canopies, and cuſhions; equipped with a band of rowers, and decorated with flags and ſtreamers: they are generally uſed for proceſſions on the water, by noblemen, officers of ſtate, or magiſtrates of great cities. Of this ſort, too, we may naturally ſuppoſe the famous barge or galley of Cleopatra, which, according to Shakeſpeare,

———————Like a burniſh'd throne,
Burnt on the water: the poop was beaten gold:
Purple her ſails; and ſo perfumed, that
The winds were love-ſick with them: the oars were
ſilver,
Which to the tune of flutes kept time, and made
The water which they beat to follow faſter,
As amorous of their ſtrokes.——
————————————At the helm
A ſeeming mermaid ſteer'd: the ſilken tackles
Swell'd with the touches of thoſe flower ſoft hands
That yarely 'form'd their office.——

There are likewiſe other barges of a ſmaller kind, for the uſe of admirals and captains of ſhips of war. Theſe are of a lighter frame, and may be eaſily hoiſted into and out of the ſhips to which they occaſionally belong.

Barge is alſo the name of a flat-bottomed veſſel of burden, for lading and diſcharging ſhips, and removing their cargoes from place to place in a harbour.

Barge-Couples, in *Architecture*, a beam mortiſed into another, to ſtrengthen the building.

Barge-Courſe, with bricklayers, a term uſed for that

that part of the tiling which projects over without the principal rafters, in all sorts of buildings where there is either a gable or a kirkin-head.

BARGHMASTER, Barmer, or Bar-Master, in the royal mines, the steward or judge of the barmote.—The bar-master is to keep two great courts of barmote yearly; and every week a small one, as occasion requires.

BARGHMOTE, or Barmot, a court which takes cognizance of causes and disputes between miners—By the custom of the mines, no person is to sue any miner for ore-debt, or for ore, or for any ground in variance, but only in the court of barmote, on penalty of forfeiting the debt, and paying the charges at law.

BARI, a very handsome and rich town of Italy, in the kingdom of Naples; the capital of Terra di Bari, and an archbishop's see. It is well fortified, is seated on the gulf of Venice, and had formerly a good harbour, but it was destroyed by the Venetians. E. Long. 17. 40. N. Lat. 41. 31.

Bari, or *Terra di Bari*, a territory of Italy, in the kingdom of Naples, of which the above-mentioned city is the capital. It is bounded on the north by the Capitanata, on the north-west by the Ulterior Principato, on the south by the Basilicata, on the south-east by the Terra de Otranto, and on the north-east by the gulf of Venice. It has no considerable river except the Offanto, which separates it from the Capitanata. The air is temperate; and the soil produces plenty of corn, fruit, and saffron: but there are a great many serpents, and spiders called *tarantulas*. See Aranea. The principal towns are Bari the capital, Frani, Andria, Bavo, Bilonto, Conversano, Monopoli, Polignano, Barletta, and Malsetto. The two first are archiepiscopal, and all the rest episcopal.

BARILLA, or Barilha, the name of a plant cultivated in Spain for its ashes, from which the purest kinds of mineral alkali or soda are obtained.

There are four plants, which, in the early part of their growth, bear so strong a resemblance to each other as would deceive any but the farmers and nice observers. These four are, *barilla*, *gazul* (or, as some call it, *algazal*), *soza*, and *salicornia* or *salicor*. They are all burnt to ashes; but applied to different uses, as being possessed of different qualities. Some of the roguish farmers mix more or less of the three last with the first; and it requires a complete knowledge of the colour, taste, and smell of the ashes to be able to detect their knavery.

Barilla is sown afresh every year. Its greatest height above ground is four inches: each root pushes out a vast number of little stalks, which again are subdivided into smaller sprigs resembling samphire; and all together form a large spreading tufted bush. The colour is bright green; as the plant advances towards maturity, this colour vanishes away till it comes at last to be a dull green tinged with brown.

Gazul bears the greatest affinity to barilla, both in quality and appearance: the principal difference consists in its growing on a still drier salter earth, consequently it is impregnated with a stronger salt. It does not rise above two inches out of the ground, spreading out into little tufts. Its sprigs are much flatter and more pulpy than those of barilla, and are still more like samphire. It is sown but once in three, four, or five years, according to the nature of the soil.

Soza, when of the same size, has the same appearance as gazul; but in time grows much larger, as its natural soil is a strong salt marsh, where it is to be found in large tufts of sprigs, treble the size of barilla, and of a bright green colour, which it retains to the last.

Salicor has a stalk of a deep green colour inclining to red, which last becomes by degrees the colour of the whole plant. From the beginning it grows upright, and much resembles a bush of young rosemary. Its natural soil is on the declivities of hills near the salt marshes, or on the edges of the small drains or channels cut by the husbandmen for the purpose of watering the fields; before it has acquired its full growth, it is very like the barilla of those seasons in which the ground has been dunged before sowing. In those years of manuring, barilla, contrary to its usual nature, comes up with a tinge of red; and when burnt falls far short of its wonted goodness, being bitter, more impregnated with salts than it should be, and raising a blister if applied for a few minutes to the tongue. Barilla contains less salt than the others: when burnt, it runs into a mass resembling a spongy stone, with a faint cast of blue.

Gazul, after burning, comes as near barilla in its outward appearance as it does while growing in its vegetable form; but if broken, the inside is of a deeper and more glossy blue. Soza and salicor are darker, and almost black within, of a heavier consistence, with very little or no sign of sponginess.

All these ashes contain a strong alkali; but barilla the best and purest, though not in the greatest quantity. Upon this principle, it is fittest for making glass and bleaching linen; the others are used in making soap. Each of them would whiten linen; but all, except barilla, would burn it. A good crop of barilla impoverishes the land to such a degree, that it cannot bear good barilla a second time, being quite exhausted. For this reason the richer farmers lay manure upon the ground, and let it lie fallow for a season; at the end of which it is sown afresh without any danger, as the weeds that have sprung up in the year of rest have carried off all the pernicious effects of the dung. A proper succession of crops is thus secured by manuring and fallowing the different parts of the farm, each in their turn. The poorer tribe of cultivators cannot pursue the same method for want of capital; and are therefore under the necessity of sowing their lands immediately after manuring, which yields them a profit just sufficient to afford a present scanty subsistence, though the quality and price of their barilla be but trifling.

The method used in making barilla is the same as that followed in Britain in burning kelp. The plant as soon as ripe is plucked up and laid in heaps, then set on fire. The salt juices run out below into a hole made in the ground, where they run into a vitrified lump, which is left about a fortnight to cool. An acre may give about a tun.

BARING of Trees, in *Agriculture*, the taking away some of the earth about the roots, that the winter-rain and snow-water may penetrate farther into

into the roots. This is frequently practiſed in the autumn.

BARJOLS, a ſmall populous town of Provence, now the department of Var, in France. E. Long. 5. 23. N. Lat. 43. 35.

BARIUM, in *Ancient Geography*, a town of Apulia, on the Adriatic; ſo called from the founders, who being expelled from the iſland Bara, built this town. It is now called Bari; ſee that article.

BARK, in the anatomy of plants, the exterior part of trees, correſponding to the ſkin of an animal. For its organization, texture, &c. ſee the article Plants.

As animals are furniſhed with a panniculus adipoſus, uſually replete with fat, which inveſts and covers all the fleſhy parts, and ſcreens them from external cold; plants are encompaſſed with a bark replete with fatty juices, by means whereof the cold is kept out, and in winter-time the ſpiculæ of ice prevented from fixing and freezing the juices in the veſſels: whence it is, that ſome ſorts of trees remain evergreen the year round, by reaſon their barks contain more oil than can be ſpent and exhaled by the ſun, &c.

The bark has its peculiar diſeaſes, and is infected with inſects peculiar to it.—It appears from the experiments of M. Buffon, that trees ſtripped of their bark the whole length of their ſtems, die in about three or four years. But it is very remarkable, that trees thus ſtripped in the time of the ſap, and ſuffered to die, afford timber heavier, more uniformly denſe, ſtronger, and fitter for ſervice, than if the trees had been cut down in their healthy ſtate. Something of a like nature has been obſerved by Vitruvius and Evelyn.

The ancients wrote their books on bark, eſpecially of the aſh and lime tree, not on the exterior, but on the inner and finer bark called *philyra*.

There are a great many kinds of barks in uſe in the ſeveral arts. Some in agriculture, and in tanning leather, as the oak-bark; ſome in phyſic, as the *quinquina* or Jeſuit's bark, mace, &c.; others in dyeing, as the bark of alder and walnut trees; others in ſpicery, as cinnamon, caſſia lignea, &c.; and others for divers uſes, as the bark of the cork tree, &c.

In the Eaſt Indies, they prepare the bark of a certain tree ſo as to ſpin like hemp. After it has been beat and ſteeped in water, they extract long threads from it, which are ſomething between ſilk and common thread; being neither ſo ſoft nor ſo gloſſy as ſilk, nor ſo rough and hard as hemp. They mix ſilk with it in ſome ſtuffs; and theſe are called *nillaes*, and *cherquemolles*.

Of the bark of a ſpecies of mulberry-tree the Japaneſe make their paper. See Morus.

In the iſland of Otaheite, the natives make their cloth, which is of three kinds, of the bark of three different trees; the paper-mulberry above mentioned, the bread-fruit tree, and the cocoa tree. That made of the mulberry is the fineſt and whiteſt, and worn chiefly by the principal people. It is manufactured in the following manner. When the trees are of a proper ſize, they are drawn up, and ſtripped of their branches; after which, the roots and tops are cut off: the bark of theſe rods being then ſlit up longitudinally, is eaſily drawn off; and, when a proper quantity has been procured, it is carried down to ſome running water, in which it is depoſited to ſoak, and ſecured from floating away by heavy ſtones: when it is ſuppoſed to be ſufficiently ſoftened, the women ſervants go down to the brook, and, ſtripping themſelves, ſit down in the water, to ſeparate the inner bark from the green part on the outſide: to do this, they place the under ſide upon a flat ſmooth board, and with a kind of ſhell ſcrape it very carefully, dipping it continually in the water till nothing remains but the fine fibres of the inner coat. Being thus prepared in the afternoon, they are ſpread out upon plantain leaves in the evening; they are placed in lengths of about 11 or 12 yards, one by the ſide of another, till they are about a foot broad, and two or three layers are alſo laid one upon the other: care is taken that the cloth ſhall be in all parts of an equal thickneſs, ſo that if the bark happens to be thinner in any one particular part of one layer than the reſt, a piece that is ſomewhat thicker is picked out to be laid over in the next. In this ſtate it remains till the morning, when great part of the water which it contained when it was laid out is either drained off or evaporated, and the ſeveral fibres adhere together, ſo as that the whole may be raiſed from the ground in one piece. It is then taken away, and laid upon the ſmooth ſide of a long piece of wood prepared for the purpoſe, and beaten by the women ſervants. The inſtrument uſed for this purpoſe is a ſquare wooden club, having each of its four ſides or faces marked, lengthwiſe, with ſmall grooves, or furrows, of different degrees of fineneſs; thoſe on one ſide being of a width and depth ſufficient to receive a ſmall pack-thread, and the others finer in a regular gradation, ſo that the laſt are not more than equal to ſewing ſilk. They beat it firſt with the coarſeſt ſide of this mallet, keeping time like our ſmiths; it ſpreads very faſt under the ſtrokes, chiefly however in the breadth, and the grooves in the mallet mark it with the appearance of threads; it is ſucceſſively beaten with the other ſides, laſt with the fineſt, and is then fit for uſe. Of this cloth there are ſeveral ſorts, of different degrees of fineneſs, in proportion as it is more or leſs beaten. The other cloth alſo differs in proportion as it is beaten; but they differ from each other in conſequence of the different materials of which they are made. The bark of the bread-fruit is not taken till the trees are conſiderably longer and thicker than thoſe of the mulberry; the proceſs afterwards is the ſame.—Of the bark, too, of a tree which they call *poerou**, they manufacture excellent matting; both a coarſe ſort which ſerves them to ſleep upon, and a finer to wear in wet weather. Of the ſame bark they alſo made ropes and lines, from the thickneſs of an inch to the ſize of a ſmall pack-thread.

* *Hibiſcus tiliaceus* of Linnæus.

Bark, or *Jeſuit's Bark*, is a name given by way of eminence to the quinquina, or cinchona. See Cinchona.

Bark, in *Navigation*, a general name given to ſmall ſhips; it is, however, peculiarly appropriated by ſeamen to thoſe which carry three maſts without a mizen topſail. Our northern mariners, who are trained in the coal-trade, apply this diſtinction to a broad ſterned ſhip which carries no ornamental figure on the ſtern or prow.

Water-Barks, are little veſſels uſed in Holland for the carriage of freſh water to places where it is wanting,

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