Edinburgh, March 6, 1810.

THE FOLLOWING

NEW WORKS

WILL SPEEDILY BE PUBLISHED, BY

ARCHIBALD CONSTABLE & CO. EDINBURGH,

AND

CONSTABLE, HUNTER, PARK, & HUNTER, LONDON.

I. CALEDONIA: or an Account, Historical and Topographical, of North Britain, from the most antient to the present times. By GEORGE CHALMERS, Esq. F. R. S. Vol. II. Quarto.

⁂ The first volume of the above work published (1807), contains the Antient History of North Britain.—The second volume, which will appear in March 1810, will detail, after an introductory chapter of 26 sections, the *Local* History of its several shires; beginning with Roxburgh, the most southern shire, and proceeding, successively, to Berwick, Haddington, Edinburgh, Linlithgow, Peebles, Selkirk, Dumfries, Kirkcudbright, Wigton, and perhaps Ayrshire: and the *Local* History of each shire will be given in eight distinct sections:—1. Of its Name; 2. Of its Situation and Extent; 3. Of its Natural Objects; 4. Of its Antiquities; 5. Of its Establishment as a Shire; 6. Of its *Civil* History; 7. Of its Agriculture, Manufactures, Trade; 8. Of its *Ecclesiastical* History; the account of each shire concluding with a *Supplemental State*, which contains, in a *Tabular form*, the Names of the several parishes, and the number of their Ministers; their Extent and Population in 1755, 1791, and 1801; with the Ministers' Stipends in 1755 and 1798, and their Patrons; forming, what Scotland does not now possess, a sort of *Liber Regis*.

This most interesting work will be completed by the publication of two other volumes. The third will contain the Local History and description of the remaining counties, on the plan stated above. The fourth volume will consist of a Topographical Dictionary, containing whatever is interesting relative to all places and objects of any importance in this part of the United Kingdom. This volume will be preceded by an Historical View of the different Languages spoken in Scotland.

II. The GENEALOGY of the EARLS of SUTHERLAND, from the origin of that illustrious House to the year 1630, with the History of the Northern parts of Scotland during that period, by Sir ROBERT GORDON of Gordonstone, Baronet, continued to the year 1651, by GILBERT GORDON of Sallagh. Published from the Original Manuscript in the possession of the Marchioness of STAFFORD. Handsomely printed in Folio.

⁂ The public is here presented not only with an accurate genealogical history of the antient house of Sutherland, but also with a minute detail of the principal transactions which occurred during a period of nearly 600 years, particularly in the counties of Sutherland and Caithness, and the Highlands of Scotland in general. The history of these parts, it is presumed, will receive more elucidation from this work than from any which the public is at present possessed of. The whole has been carefully transcribed by the kind permission of the Marchioness of Stafford, from the original manuscript preserved at Dunrobin Castle.

An Appendix will be added, containing an inventory of writs of the Earldom, and the work will be illustrated by several Engravings.

III. The PEERAGE of SCOTLAND; containing an "Historical and Genealogical Account of the Nobility of that Kingdom, from their Origin to the present Generation." Collected from the Public Records, and Antient Chartularies of this Nation, the Charters, and other Writings of the Nobility, and the Works of our best Historians. By Sir ROBERT DOUGLAS of Glenbervie, Baronet. Continued to the present time by J. P. WOOD, Esq. Handsomely Printed in Two Volumes Folio, with the Arms of each Family beautifully Engraven.

⁂ A few Copies are printed on Large Paper, forming Two Superb Volumes, with First Impressions of the Plates; and as the Number printed is very limited, Noblemen and Gentlemen who wish to secure copies, are respectfully requested to leave their Names, either with ARCHIBALD CONSTABLE and COMPANY, Edinburgh, or with CONSTABLE, HUNTER, PARK, and HUNTER, 10, Ludgate Street, London, where Specimens of the Work may now be seen. The Plan of the Work is fully detailed in the following *Advertisement from the Editor*.—The Peers of Scotland, the Representatives of dormant, attainted, and extinct titles, and persons connected with them, are respectfully informed, that this edition is now in the press.

The first edition was published in 1764. In the introduction, Sir Robert Douglas thus expresses himself: "The necessity of publishing a New Peerage of Scotland, and "the utility of it, is acknowledged by all. The Compiler of the present Work has "attempted it on a more regular and accurate plan than has hitherto appeared. How "far he has succeeded, the world must judge. But if the most assiduous application "for many years; if a painful inquiry into the public records and autient chartularies; "if an unwearied search after every degree of knowledge necessary for carrying on so "arduous a task,—if these have any merit, or deserve the favour of the public, the Au- "thor flatters himself this Work, on perusal, will not be found deficient. The chief "and principal point the Author had in view, and the great object of his attention "[was], in a plain and distinct manner, to deduce the history of each family, from "its origin to the present generation, and to ascertain their genealogy and chronology "by indisputable documents."

That edition has already become scarce. Subsequent researches have thrown no small light on the histories of particular families; and, from the lapse of time, numerous alterations have necessarily taken place in the noble houses. On these accounts, it has been judged, that a new edition of Sir Robert Douglas's Peerage, with a continuation to the present time, may not be deemed unacceptable to the public.

In the preface to the first edition, Sir Robert Douglas states, that "notwithstanding "all that has been done, there doubtless may and will be mistakes, such as are unavoidable in a work of this kind, though the Author hopes they will not be found "numerous, as all manner of pains has been taken to avoid them, as well by the "labour bestowed upon the compilation, as by putting it in the power of every Peer "to correct or add to the history of his own family, by sending him a manuscript "copy some time before publication, they producing sufficient documents in support "of any alteration made."

In conformity to this plan, calculated for the prevention of error, it is proposed, in the first place, to transmit to the Peers of Scotland, and Representatives of dormant, attainted, and extinct titles, (or their agents), that part of Sir Robert Douglas's Work which treats of their respective families, so disposed on writing paper, as to admit of additions and corrections being made with facility; and, in the next place, when the amended account of each family is put to the press, to transmit, in like manner, the proof sheets of such amended account, before throwing off the impression.

This arrangement, although adding considerably to the expence of the Work, will, it is hoped, meet with the approbation of all concerned. When it is considered on how comparatively trifling a degree of exertion on the part of each family, the formation of a full and accurate Peerage of Scotland depends, the Editor flatters himself with the hope, that the Nobility will be induced to take the trouble of revising, or of giving directions to their Agents to correct, the accounts of their respective families, from charters, parish registers, and other authentic sources, to their own satisfaction.

In the continuation of Sir Robert Douglas's Peerage to the present time, the Editor has used every endeavour to obtain correct information; sensible that, if genealogical histories can pretend to merit, it must consist in their accuracy, for without that recommendation, they would become reprehensible, from their tendency to mislead.

The Editor takes this opportunity of returning his grateful acknowledgements for the valuable communications received from several of the Nobility and their connections, in reference to his original plan of a Peerage of Scotland, from the Union of Great Britain downwards. For the reasons already stated, he has been induced to extend that plan; and begs leave to solicit such information as may enable him to carry it into full effect, particularly with regard to the errors of the first edition.

The Editor has only to add, that communications on the subject, addressed to him at No. 92, Prince's Street, Edinburgh, in franked covers, not exceeding the limited weight, or where these cannot be obtained, under cover to the Secretary of the General Post-Office of Scotland, Edinburgh, will be carefully attended to, and properly noticed in the Work.

IV. SWIFT'S

IV. SWIFT'S WORKS, Edited by Walter Scott, Esq. with a Life of the Author, Notes Critical and Illustrative, &c. &c. Nineteen Volumes Octavo, handsomely printed, with a few copies on Royal Paper. (Edinburgh, March 1809.)

⁂ The present edition of this incomparable English Classic is offered to the public on a plan different from that adopted by former editors. In the Life of the Author, it is proposed to collate and combine the various information which has been given by Mr Sheridan, Lord Orrery, Dr Delany, Mr Pilkington, Dean Swift, Dr Johnson, and others, into one distinct and comprehensive narrative; which, it is hoped, may prove neither a libel or apology for Swift, nor a collection from the pleadings of those who have written either; but a plain, impartial, and connected biographical narrative. By the favour of distinguished friends in Ireland, the editor hopes to obtain considerable light upon some passages in the Dean's life, which have hitherto perplexed his biographers. In preparing the text and notes, no labour or expence has been spared to procure original information. The Tale of a Tub, for example, is illustrated with the marginal notes of the learned Bentley, transcribed from manuscript jottings on his own copy. Although neither long nor numerous, they offer some curious elucidations of the author, and afford a singular instance of the equanimity with which the satire even of Swift was borne by the venerable scholar against whom it was so unadvisedly levelled. Some preliminary critical observations are offered on the various literary productions of the Dean of St Patrick's; and historical explanations and anecdotes accompany his political treatises. All those pieces which, though hitherto admitted into Swift's works, are positively ascertained not to be of his composition, are placed in the Appendix, or altogether retrenched. On the other hand, the Editor is encouraged to believe, that, by accurate research, some gleanings may yet be recovered, which have escaped even the laudable and undeniable industry of Swift's last editor. So that, upon the whole, he hopes the present edition will be fully more complete than those of late years. The work will appear in the course of 1811.

V. The WORKS of GAWIN DOUGLAS, Bishop of Dunkeld, with Historical and Critical Dissertations on his Life and Writings, Notes and a Glossary. By the Right Hon. Sylvester (Douglas) Lord Glenbervie. Four Volumes Octavo, elegantly printed.

⁂ The whole works of Gawin Douglas, consisting of his translation of Virgil's Æneid, the Palace of Honour, and King Hart, are now, for the first time, collected into one edition. Two Dissertations, the one on the Family of Douglas, the other, on the Poet's Life and Writings, will be prefixed, and copious notes added. The text of Ruddiman's edition of the Æneid has been collated with the following manuscripts: viz. Two in the Library of the University of Edinburgh, another in the possession of the Marquis of Bath at Longleet, and the fourth at Lambeth Palace. The excellent Glossary of Ruddiman is made the basis of that in the present work, but considerably enlarged, and extended to the other poems.

VI. LETTERS of ANNA SEWARD, written between the years 1784 and 1807, bequeathed to Mr Constable for publication. Five Volumes Post Octavo, with Portraits, and other Plates.

VII. METRICAL ROMANCES of the Thirteenth, Fourteenth, and Fifteenth Centuries. Published from antient manuscripts, and illustrated by an Introduction, Notes, and a Glossary. By Henry Weber, Esq. In Three Volumes Post Octavo.

⁂ The present publication is intended to comprehend the most valuable of those Romances, which have not yet been submitted to the public. *The Life of Alexander*, attributed by Warton to Adam Davie, and strongly recommended by him for publication, will form the first article; and will be followed by *Richard Coeur de Lion*, which, besides its very considerable poetical merit, must excite a strong national interest; and by others, selected either for the beauty of the tale, or some circumstances rendering them curious; among which a few Comical Romances will be found. To the introduction, the Editor, at the request of several gentlemen most anxious for the publication, has subjoined a summary account of the German early Poetry and Romance; a subject of high interest, but as yet entirely unknown to this nation, and but little cultivated on the Continent. If the present publication should meet with the encouragement, which the importance of this species of composition in the history of English Poetry deserves, a continuation, comprising those excluded from this selection, on account of its limited extent, will be published.

VIII. The HISTORY and CHRONICLES of SCOTLAND, by Robert Lindsay of Pitscottie. Edited from Antient and Authentic Manuscripts, by John Graham Dalyell, Esq. One Volume Quarto, handsomely printed, with a Portrait of King James V. from an Original Picture.

IX. SHIPWRECKS and DISASTERS at SEA, according to the most Authentic Accounts, Antient and Modern. Three Volumes Octavo.

X. The DRAMATIC WORKS of John Ford; with an Introduction and Explanatory Notes. By Henry Weber, Esq. In Two Volumes Octavo.

⁂ This author was coeval with Fletcher and Massinger, and others who succeeded Shakespeare. He imitated the latter with a success sufficient to provoke the envy of Ben Johnson, and to excite great admiration from his contemporaries. Notwithstanding their great merit, his plays have never, with the exception of two, been reprinted, and are now, for the first time, collected in a uniform edition.

XI. HISTORY of the REFORMATION in SCOTLAND. By George Cook, D. D. Minister of Laurencekirk, Author of "An Illustration of the General Evidence establishing the Reality of Christ's Resurrection." Three Volumes Octavo.

XII. RESEARCHES into the ORIGIN and AFFINITY of the GREEK and TEUTONIC LANGUAGES. By A. Murray, F. A. S. E. and Secretary for Foreign Correspondence. One Volume Quarto.

⁂ The immediate object of this work is, to illustrate the early state and connexion of these languages, on accurate and *philosophical* principles. The light which is thus thrown on the structure of the Greek tongue, gives a NEW and interesting form to the whole of classic philology; exhibits an extensive view of the process by which the mind invents and improves articulate speech; and leads to a developement of the origin of the most antient European nations. The notices ascertained in the course of investigation depend, not on conjecture, but on a comparison of almost every European language with those to which it is respectively allied. In the train of inquiry pursued in the researches above mentioned, particular regard has been paid to the Oriental tongues; those having been examined which bear no affinity to the Teutonic, as well as those which appear to be related to it. For a plan and outline of the whole work, reference may be made to page 505 of an "Account of the Life and Writings of James Bruce of Kinnaird, Esq. Author of Travels to discover the Source of the Nile, in the years 1768—1773," published 1808.

XIII. The WORKS of SIR WALTER RALEGH, Knight; with a Biographical and Critical Introduction. Seven Volumes Octavo, handsomely printed.

The Writings of Sir Walter Ralegh, have been highly praised by the greatest Masters of English Literature, both for solidity of matter, and dignity of style. But these Writings, which consist of a History of the World, a Voyage to Guiana, and various Discourses upon Government, War, Commerce, and Navigation, besides Poems and Letters, have never yet been published in a uniform shape. The present Edition is intended to supply this desideratum; and it is the more necessary, as both the last edition of his History, by Oldys, and of his Miscellaneous Works, by Birch, have become equally rare.

In this Edition, the Miscellaneous Pieces will be re-arranged and classified; and besides occasional illustrative Notes, there will be added some Letters of Ralegh, which had not appeared at the time of Dr Birch's Publication. The Introductory Essay will contain, within moderate limits, a clear, and it is hoped, interesting Account of the Actions, Fortunes, and Character of this extraordinary Man, founded upon a thorough examination of all that has been written on the subject of his Life, and the transactions in which he was engaged: together with a connected view of the scope and merits of his literary labours.

⁂ A FEW Copies will be printed on Royal Paper, and the Work will be embellished with a Portrait of Ralegh, from an Original Painting, and a Fac-simile of his Writing.

XIV. MEMOIRS of the Most Remarkable Passages in the Life of Sir JAMES TURNER, Knight, from the Commencement of his Military career in Germany, in 1632, (the year in which Gustavus Adolphus was killed), till his Trial for Oppression and Extortion, and Acquittal, before the Privy-Council, in 1668; written by Himself. Published from the Original Manuscript in the possession of the Publishers. One Volume Octavo; *with a Portrait of the Author.*

⁂ The Author of this Narrative served as a Major in Lord Sinclair's Regiment, during the Rebellion which broke out in Ireland in 1641; and afterwards in the Scotish army in England, till he was made prisoner, with the Duke Hamilton, by Lambert, at Uxeter. Obtaining his liberty in 1649, he withdrew to the Continent, where he remained in Denmark, Germany, Holland, and France, till the Restoration. In 1666, he was surprised at Dumfries by the Covenanters, with whom he continued a prisoner till their defeat by Dalyell, at Pentland Hills. His Memoirs, embracing so eventful a period in the History of Europe, are peculiarly interesting, from the light which they throw on many of the most remarkable events and characters of the time. He also wrote, and published in 1683, "Pallas Armata," a series of Military Essays; was a man of considerable talents, much experience, extensive reading, and shrewd discernment; and his writing in the first person gives to his Memoirs, as he has managed it, a dramatic effect, by which the Reader is made not only a Spectator, but also an Auditor of all that passes.

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Edinburgh, 1810.

16
Table formed from the rule,

Equation of the Boiling Point.

Barometer.	*Equotion.*	*Difference.*
31.0	+ 1.57	0.78
30.5	+ 0.79	0.79
30.0	0.00	0.80
29 5	— 0.80	0.82
29.0	— 1.62	0.83
28.5	— 2.45	0.85
28.0	— 3.31	0.86
27.5	— 4.16	0.88
27.0	— 5.04	

The numbers in the firſt column of this table expreſs heights of the quickſilver in the barometer in Engliſh inches and decimal parts: the ſecond column ſhows the equation to be applied, according to the ſign prefixed, to 212° of Bird's Fahrenheit, to find the true boiling point for every ſuch ſtate of the barometer. The boiling point for all intermediate ſtates of the barometer may be had with ſufficient accuracy, by taking proportional parts, by means of the third column of differences of the equations. See Philoſophical Tranſactions, vol. lxiv. art. 30.; alſo Dr Maſkelyne's Paper, vol. lxiv. art. 20.

17
Sir George Shuckburgh's obſervations compared with De Luc's rules.

In the following table we have the reſult of fifteen different obſervations made by Sir George Shuckburgh compared with the reſult of M. de Luc's rules.

Height of the Barometer reduced to the ſame temperature of 50°.	Mean Boiling Point by Obſervation.	Boiling Point by De Luc's Rules.	Height of Barometer.	Boiling Point by Obſervation.	Boiling Point by De Luc's Rules.
Inch.	°	°	Inch.	°	°
26.498	207.07	208.54	30.008	213.22	213.47
27.241	208.64	208.84	30.207	213.58	213.79
27.954	209.87	210.03	30.489	214.15	214.23
28.377	210.50	210.81	30.763	214.37	214.66
28.699	211.27	211.34	30.847	214.83	214.79
28.898	211.50	211.67	30.957	214.96	214.96
28.999	211.60	211.85			
29.447	212.55	212.74			
29.805	212.95	213.15			

Sir George Shuckburgh has alſo ſubjoined the following general table for the uſe of artiſts in conſtructing the thermometer, both according to his own obſervations and thoſe of M. de Luc.

Height of the Barometer.	Correct. of the Boiling Point.	Difference.	Correct. according to M de Luc.	Difference.
	°		°	
26.0	— 7.09	.91	— 6.83	.90
26.5	— 6.18	.91	— 5.93	.89
27.0	— 5.27	.90	— 5.04	.88
27.5	— 4.37	.89	— 4.16	.87
28.0	— 3.48	.89	— 3.31	.86
28.5	— 2.59	.87	— 2.45	.83
29.0	— 1.72	.87	— 1.62	.82
29.5	— 0.85	.85	— 0.80	.80
30.0	0.00	.85	0.00	.79
30.5	+ 0.85	.84	+ 0.79	.78
31.0	+ 1.69		+ 1.57	

18
Obſervations made by a committee of the Royal Society for adjuſting the fixed points.

The Royal Society, fully appriſed of the importance of adjuſting the fixed points of thermometers, appointed a committee of ſeven gentlemen to conſider of the beſt method for this purpoſe; and their report is publiſhed in the Phil. Tranſ. vol. lxvii. part ii. art. 37.

They obſerved, that though the boiling point be placed ſo much higher on ſome of the thermometers now made than on others, yet this does not produce any conſiderable error in the obſervations of the weather, at leaſt in this climate; for an error of 1½° in the poſition of the boiling point, will make an error only of half a degree in the poſition of 92°, and of not more than a quarter of a degree in the point of 62°. It is only in nice experiments, or in trying the heat of hot liquors, that this error in the boiling point can be of much importance.

In adjuſting the freezing as well as the boiling point, the quickſilver in the tube ought to be kept of the ſame heat as that in the ball. When the freezing point is placed at a conſiderable diſtance from the ball, the pounded ice ſhould be piled to ſuch a height above the ball, that the error which can ariſe from the quickſilver in the remaining part of the tube not being heated equally with that in the ball, ſhall be very ſmall, or the obſerved point muſt be corrected on that account according to the following table:

19
Table for correcting the freezing point.

Heat of the Air.	Correction.
42°	.00087
52	.00174
62	.00261
72	.00348
82	.00435

The correction in this table is expreſſed in 1000th parts of the diſtance between the freezing point and the ſurface of the ice: e. gr. if the freezing point ſtands ſeven inches above the ſurface of the ice, and the heat of the room is 62, the point of 32° ſhould be placed 7×00261, or .018 of an inch lower than the obſerved point. A diagonal ſcale will facilitate this correction.

20
The quickſilver in the tube ought to be heated to the ſame degree as that in the ball.

The committee obſerve, that in trying the heat of liquors, care ſhould be taken that the quickſilver in the tube of the thermometer be heated to the ſame degree as that in the ball; or if this cannot be done conveniently, the obſerved heat ſhould be corrected on that account; for the manner of doing which, and a table calculated for this purpoſe, we muſt refer to their excellent report in the Phil. Tranſ. vol. lxvii. part ii. art. 37.

21
The tubes ought to be cylindrical and capillary.

With regard to the choice of tubes, they ought to be exactly cylindrical. But though the diameter ſhould vary a little, it is eaſy to manage that matter in the manner propoſed by the Abbé Nollet *, by making a ſmall portion of the quickſilver, e. gr. as much as fills up an inch or half an inch, ſlide backward and forward in the tube; and thus to find the proportions of all its inequalities, and from thence to adjuſt the diviſions to a ſcale of the moſt perfect equality. The capillary tubes are preferable to others, becauſe they require ſmaller bulbs, and they are alſo more ſenſible, and leſs brittle. The moſt convenient ſize for common experiments has the internal diameter about the 40th or 50th of an inch, about nine inches long, and made of thin glaſs, that the riſe and fall of the mercury may be better ſeen.

22
The number of degrees into which the ſcale ought to be divided.

The next thing to be conſidered, is of what number of degrees or diviſions the ſcale ought to conſiſt, and from what point it ought to commence. As the number of the diviſions of the ſcale is an arbitrary matter, the ſcales which have been employed differ much from one another in this circumſtance. Fahrenheit has made 180 degrees between the freezing and boiling water point. Amontons made 73, and Sir Iſaac Newton only 34. There is, however, one general maxim, which ought to be obſerved: *That ſuch an arithmetical number ſhould be choſen as can eaſily be divided and ſubdivided, and that the number of diviſions ſhould be ſo great that there ſhall ſeldom be occaſion for fractions.* The number 80 choſen by Reaumur anſwers extremely well in this reſpect, becauſe it can be divided by ſeveral figures without leaving a remainder; but it is too ſmall a number: the conſequence of which is, that the degrees are placed at too great a diſtance from one another, and fractions muſt therefore be often employed. We think, therefore, that 160 would have been a more convenient number. Fahrenheit's number 180 is large enough, but when divided its quotient ſoon becomes an odd number.

23
At what point the ſcale ought to commence.

As to the point at which the ſcale ought to commence, various opinions have been entertained. If we knew the beginning or loweſt degree of heat, all philoſophers would agree, that the loweſt point of the thermometer ought to be fixed there; but we know neither the loweſt nor the higheſt degrees of heat; we obſerve only the intermediate parts. All that we can do, then, is to begin it at ſome invariable point, to which thermometers made in different places may eaſily be adjuſted. If poſſible too, it ought to be a point at which a natural well-known body receives ſome remarkable change from the effects of heat or cold. Fahrenheit began his ſcale at the point at which ſnow and ſalt congeal. Kirwan propoſes the freezing point of mercury. Sir Iſaac Newton, Hales, and Reaumur adopted the freezing point of water. The objection to Fahrenheit's loweſt point is, that it commences at an artificial cold never known in nature, and to which we cannot refer our feelings, for it is what few can ever experience. There would be ſeveral great advantages gained, we allow, by adopting the freezing point of mercury. It is the loweſt degree of cold to which mercury can be applied as a meaſure; and it would render unneceſſary the uſe of the ſigns plus and minus, and the extenſion of the ſcale below 0. But we object to it, that it is not a point well known; for few, comparatively ſpeaking, who uſe thermometers, can have an opportuity of ſeeing mercury congealed. As to the other advantage to be gained by adopting the freezing point of mercury, namely, the abolition of negative numbers, we do not think it would counterbalance the advantage to be enjoyed by uſing a well-known point. Beſides, it may be aſked, Is there not a propriety in uſing negative numbers to expreſs the degree of cold, which is a negative thing? Heat and cold we can only judge of by our feelings: the point then at which the ſcale ſhould commence, ought to be a point which can form to us a ſtandard of heat and cold; a point familiar to us from being one of the moſt remarkable that occurs in nature, and therefore a point to which we can with moſt clearneſs and preciſion refer to in our minds on all occaſions. This is the freezing point of water choſen by Sir Iſaac Newton, which of all the general changes produced in nature by cold is the moſt remarkable. It is, therefore, the moſt convenient point, for the thermometers to be uſed in the temperate and frigid zones; we may ſay over the globe, for even in the hotteſt countries of the torrid zone many of the mountains are perpetually covered with ſnow.

24
Thermometers generally uſed.

The thermometers which are at preſent in moſt general uſe, are Fahrenheit's, De l'Iſle's, Reaumur's, and Celſius's. Fahrenheit's is uſed in Britain, De l'Iſle's in Ruſſia, Reaumur's and the thermometre centigrade in France, and Celſius's, the ſame as the laſt named, in Sweden. They are all mercurial thermometers. For their deſcription and the method of comparing them together, ſee CHEMISTRY, N° 198—201. See alſo Plate DXXXIV.

25
Account of ſelf-regiſtering thermometers

As in meteorological obſervations it is neceſſary to attend to the greateſt riſe and fall of the thermometer, attempts have been made to conſtruct a thermometer which might regiſter the greateſt degree of heat, or greateſt degree of cold, which took place during the abſence of the obſerver. In 1757 Lord Charles Cavendiſh preſented to the Royal Society of London a thermometer in two different forms; the one contrived to mark the greateſt degree of heat, and the other the greateſt degree of cold.

26
Lord Charles Cavendiſh's thermometer.
Plate DXXXIII. Fig. 3.

The firſt conſiſts of a glaſs tube AB, with a cylindrical bulb B at the lower end, and capillary at the top, over which there is fixed a glaſs ball C. The bulb and part of the tube are filled with mercury, the top of which ſhows the degrees of heat as uſual. The upper part of the tube above the mercury is filled with ſpirit of wine; the ball C is alſo filled with the ſame liquor almoſt to the top of the capillary tube. When the mercury riſes the ſpirit of wine is alſo raiſed, and falls into the ball C, which is ſo made that the liquor cannot return into the tube when the mercury ſinks; conſequently the height of the ſpirit of wine in the ball, added to that in the tube, will give the greateſt degree of heat to which the thermometer has pointed ſince laſt obſervation. When a new obſervation is to be made, the inſtrument muſt be inclined

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* *Lecons de Phyſ. Exp.* tom. iv. p. 376.

inclined till the liquor in the ball cover the end of the capillary tube.

In this thermometer it is evident that the mercury muſt be affected by the weight and elaſticity of the ſpirit of wine, and therefore it will not correſpond to any of the common mercurial thermometers.

Fig. 4. The thermometer for ſhowing the greateſt degree of cold is repreſented in fig. 4. by the crooked tube ABCD. This inſtrument is filled with ſpirit of wine, with the addition of as much mercury as is ſufficient to fill both legs of the ſyphon, and about a fourth or fifth part of the hollow ball C. We are not told what the proportion of mercury was to that of ſpirit of wine. The degrees of heat are ſhown by the riſe or fall of the mercury in the leg AB. The thermometer marks the greateſt fall by means of the hollow ball C. When the mercury in the longer leg ſinks by cold, that in the ſhorter will riſe and run over into the ball C, from which it cannot return when the mercury ſubſides in the ſhorter and riſes in the longer leg. The upper part of the ſhorter leg will therefore be filled with a column of ſpirits of a length proportional to the increaſe of heat; the bottom or lower ſurface of which, by means of a proper ſcale, will ſhow how much the mercury has been lower than it is; which being ſubtracted from the preſent height will give the loweſt point to which the mercury has fallen. That the thermometer may be fitted for a new obſervation, the mercury muſt be made to run back from the ball into the ſhorter leg, by inclining the tube and heating the ball.

27 Mr Six's thermometer. Fig. 5. In 1782 Mr Six propoſed another ſelf-regiſtering thermometer. It is properly a ſpirit of wine thermometer, though mercury is alſo employed for ſupporting an index. *a b* is a thin tube of glaſs 16 inches long, and $\frac{5}{10}$ths of an inch caliber: *c d e* and *f g h* are ſmaller tubes about $\frac{1}{20}$th of an inch caliber. Theſe three tubes are filled with highly rectified ſpirit of wine, except the ſpace between *d* and *g*, which is filled with mercury. As the ſpirit of wine contracts or expands in the middle tube, the mercury falls or riſes in the outſide tubes. An index, ſuch as that repreſented in fig. 6. is placed on the ſurface, within each of theſe tubes, ſo light as to float upon it. *k* is a ſmall glaſs tube $\frac{3}{4}$ths of an inch long, hermetically ſealed at each end, and incloſing a piece of ſteel wire nearly of its own length. At each end *l*, *m*, of this ſmall tube, a ſhort tube of black glaſs is fixed, of ſuch a diameter as to paſs freely up and down within either of the outſide tubes of the thermometer *c e* or *f h*. From the upper end of the index is drawn a ſpring of glaſs to the fineneſs of a hair, and about $\frac{5}{7}$ths of an inch long; which being placed a little oblique, preſſes lightly againſt the inner ſurface of the tube, and prevents the index from deſcending when the mercury deſcends. Theſe indexes being inſerted one into each of the outſide tubes, it is eaſy to underſtand how they point out the greateſt heat or cold that has happened in the obſerver's abſence. When the ſpirit of wine in the middle tube expands, it preſſes down the mercury in the tube *h f*, and conſequently raiſes it in the tube *e c*; conſequently the index on the left hand tube is left behind and marks the greateſt cold, and the index in the right hand tube riſes and marks the greateſt heat.

28 Rutherford's thermometer. In 1790 a paper was given in to the Royal Society of Edinburgh, deſcribing two thermometers, newly invented, by Dr John Rutherford of Middle Bailiſh; the one for regiſtering the higheſt and the other for regiſtering the loweſt degree of heat to which the thermometer has riſen or fallen during the abſence of the obſerver. An account of them may be found in the third volume of the Tranſactions of the Society.

29 Mr Keith's thermometer. A new ſelf-regiſtering thermometer has been invented by Mr Keith of Ravelſtone, which we conſider as the moſt ingenious, ſimple, and perfect, of any which has hitherto appeared. Its ſimplicity is ſo great, that it requires only a very ſhort deſcription to make it intelligible.

Fig. 7. AB is a thin glaſs tube about 14 inches long and $\frac{3}{4}$ths of an inch caliber, cloſe or hermetically ſealed at top. To the lower end, which is open, there is joined the crooked glaſs tube BE, ſeven inches long, and $\frac{4}{10}$ths of an inch caliber, and open at top. The tube AB is filled with the ſtrongeſt ſpirit of wine, and the tube BE with mercury. This is properly a ſpirit of wine thermometer, and the mercury is uſed merely to ſupport a piece of ivory or glaſs, to which is affixed a wire for raiſing one index or depreſſing another, according as the mercury riſes or falls. E is a ſmall conical piece of ivory or glaſs, of ſuch a weight as to float on the ſurface of the mercury. To the float is joined a wire called the *float-wire*, which reaches upwards to H, where it terminates in a knee bent at right angles. The float-wire, by means of an eye at *a*, moves eaſily along the ſmall harpſichord wire GK. LL are two indexes made of thin black oiled ſilk, which ſlide upwards or downwards with a force not more than two grains. The one placed above the knee points out the greateſt riſe, and the one placed below it points out the greateſt fall, of the thermometer.

When the inſtrument is to be prepared for an obſervation, both indexes are to be brought cloſe to the knee H. It is evident, that when the mercury riſes, the float and float wire, which can be moved with the ſmalleſt force, will be puſhed upwards till the mercury become ſtationary. As the knee of the float-wire moves upwards it will carry along with it the upper index L. When the mercury again ſubſides, it leaves the index at the higheſt point to which it was raiſed, for it will not deſcend by its own weight: As the mercury falls the float-wire does the ſame; it therefore brings along with it the lower index L, and continues to depreſs it till it again becomes ſtationary or aſcend in the tube; in which caſe it leaves the lower index behind it as it had formerly left the upper. The ſcale to which the indexes point is placed parallel to the ſlender harpſichord wire. It may be ſeen more diſtinctly in fig. 8. That the ſcale and indexes may not be injured by the wind and rain, a cylindrical glaſs cover, cloſe at top, and made ſo as to exactly fit the part GF, is placed over it.

The ingenious inventor has another improvement in contemplation, which, if upon trial it be found to anſwer, will make this thermometer as perfect as can be deſired, provided there do not ariſe ſome errors from the variable preſſure of the atmoſphere. He propoſes to adopt clock-work to this thermometer, in ſuch a way as to regiſter with the utmoſt preciſion the degrees of heat and cold for every month, day, and minute in the year. The principles on which this clockwork is to be formed we ſhall forbear to deſcribe, hoping that the author himſelf, after his experiment has met with the ſucceſs which we ardently wiſh, will favour the world with his own account of it.

The ſame ingenious gentleman has invented a ſelf-regiſtering barometer, upon the ſame principles with his ſelf-regiſtering thermometer. We have had the pleaſure of ſeeing both; and are convinced that they will fully gratify the wiſhes of all who are engaged in meteorological ſtudies. He is alſo in expectation of being ſoon able to produce an air-thermometer free from the defects of thoſe which were formerly made, as he has found out a way of preventing it from being affected by the preſſure of the atmoſphere.

30
M. De Luc's ſuppoſed improvements.

M. de Luc has deſcribed the beſt method of conſtructing a thermometer, fit for determining the temperature of the air, in the menſuration of heights by the barometer. He has alſo ſhown how to divide the ſcale of a thermometer, ſo as to adapt it for aſtronomical purpoſes in the obſervation of refractions.

31
Mr Cavallo has propoſed a thermometrical barometer.

Mr Cavallo, in 1781, propoſed the conſtruction of a thermometrical barometer, which, by means of boiling water, might indicate the various gravity of the atmoſphere, or the height of the barometer. But as he does not ſay that the inſtrument has been tried with the deſired ſucceſs, we forbear to deſcribe it. Thoſe who wiſh to know his ideas reſpecting it may conſult the Philoſophical Tranſactions, vol. lxxi. p. 524.

32
The thermometers deſcribed above too limited.

The thermometers hitherto deſcribed are very limited in their extent; they indeed point out to us the loweſt degrees of heat which are commonly obſerved even in cold climates, but they by no means reach to thoſe degrees of heat which are very familiar to us. The mercurial thermometer extends no farther than to 600 of Fahrenheit's ſcale, the heat of boiling mercury; but we are ſure that the heat of ſolid bodies, when heated to ignition, or till they emit light, far exceeds the heat of boiling mercury.

33
Sir Iſaac Newton's method of extending the ſcale of the thermometer.

In order to remedy this defect, Sir Iſaac Newton, whoſe genius overcame theſe obſtacles which ordinary minds could not approach, attempted by an ingenious experiment to extend the ſcale to any degree required. Having heated a maſs of iron red hot, and expoſed it to the cold air, he obſerved the time which elapſed till it became cold, or of the ſame temperature with the air; and when the heat ſo far decreaſed that he could apply ſome known meaſure (as a thermometer) to it, he obſerved the degrees of heat loſt in given times; and thence drew the general concluſion, that the quantities of heat loſt in given ſmall ſpaces are always proportional to the heat remaining in the body, reckoning the heat to be the exceſs by which it is warmer than the ambient air. So that taking the number of minutes which it took to cool after it came to a determined point in an arithmetical progreſſion, the decrements of the heat of the iron would be continually proportional. Having by this proportion found out the decrements of heat in a given time after it came to a known point, it was eaſy, by carrying upwards the ſame proportion to the beginning of its cooling, to determine the greateſt heat which the body had acquired. This proportion of Sir Iſaac's was found by Dr Martine to be ſomewhat inaccurate. The heat of a cooling body does not decreaſe exactly in proportion to that which the body retains. As the reſult of many obſervations, he found that two kinds of proportion took place, an arithmetical as well as the geometrical proportion which Sir Iſaac Newton had adopted; namely, that the decrements of heat were partly proportional to the times (that is, that quantities of heat are loſt in equal times), as well as partly in proportion to the remaining heat; and that if theſe two are added together the rule will be ſufficiently accurate. By the geometrical proportion which Sir Iſaac Newton adopted he diſcovered the heat of metals red hot or in fuſion.

Martine's Eſſays.

34
Mr Wedgwood's thermometer for meaſuring high degrees of heat

This method, ſo ſucceſsfully purſued by Sir Iſaac, was ſufficient to form a ſcale of high degrees of heat, but was not convenient for practical purpoſes. Accordingly the ingenious Mr Joſiah Wedgwood, who is well known for his great improvement in the art of pottery, applied himſelf in order to diſcover a thermometer which might be eaſily managed. After many experiments recorded in the Philoſophical Tranſactions, but which it is unneceſſary to detail in this place, he has invented a thermometer which marks with much preciſion the different degrees of ignition from a dull red heat viſible in the dark to the heat of an air-furnace. This thermometer is extremely ſimple. It conſiſts of two rulers fixed upon a ſmooth flat plate, a little farther aſunder at the one end than at the other, leaving an open longitudinal ſpace between them. Small pieces of alum and clay mixed together are made of ſuch a ſize as juſt to enter at the wide end; they are then heated in the fire along with the body whoſe heat we wiſh to determine. The fire, according to the degree of heat it contains, diminiſhes or contracts the earthy body, ſo that when applied to the wide end of the gage, it will ſlide on towards the narrow end, leſs or more according to the degree of heat to which it has been expoſed.

35
Deſcribed.
Fig. 9.

That this inſtrument may be perfectly underſtood, we have given a repreſentation of it in fig. 9. ABCD is a ſmooth flat plate; and EF and GH two rulers or flat pieces, a quarter of an inch thick, fixed flat upon the plate, with the ſides that are towards one another made perfectly true, a little farther aſunder at one end EG than at the other end FH: thus they include between them a long converging canal, which is divided on one ſide into a number of ſmall equal parts, and which may be conſidered as performing the offices both of the tube and ſcale of the common thermometer. It is obvious, that if a body, ſo adjuſted as to fit exactly at the wider end of this canal, be afterwards diminiſhed in its bulk by fire, as the thermometer pieces are, it will then paſs further in the canal, and more and more ſo according as the diminution is greater; and converſely, that if a body, ſo adjuſted as to paſs on to the narrow end, be afterwards expanded by fire, as is the caſe with metals, and applied in that expanded ſtate to the ſcale, it will not paſs ſo far; and that the diviſions on the ſide will be the meaſures of the expanſions of the one, as of the contractions of the other, reckoning in both caſes from that point to which the body was adjuſted at firſt.

Philoſophical Tranſactions, vol. lxxiv.

I is the body whoſe alteration of bulk is thus to be meaſured. This is to be gently puſhed or ſlid along towards the end FH, till it is ſtopped by the converging ſides of the canal. See CHEMISTRY, Nº 1412.

THERMOPYLÆ, in *Ancient Geography*, a narrow paſs or defile, between the waſh of the Sinus Maliacus on the eaſt, and ſteep mountains, reaching to Oeta, made dreadful by unpaſſable woods, on the weſt; leading from Theſſaly to Locris and Bœotia. Theſe mountains

tains divide Greece in the middle, in the ſame manner as the Apennine does Italy; forming one continued ridge from Leucate on the weſt to the ſea on the eaſt, with thickets and rocks interſperſed; that perſons even prepared for travelling, much leſs an army encumbered with baggage, cannot eaſily find a commodious paſſage. In the valley verging towards the Sinus Maliacus, the road is only ſixty paces broad; the only military way for an army to paſs, if not obſtructed by an enemy; and therefore the place is called *Pyle*, and by others, on account of its hot water, *Thermopylæ*. Ennobled by the brave ſtand made by Leonidas and 300 Spartans againſt the whole army of Perſia; and by the bold reſolution of blind Euthycus, chooſing rather to fall there in fight, than return to Sparta, and eſcape the common danger. Famous alſo for the Amphictyones, the common council or ſtates general of Greece, aſſembling there twice a-year, ſpring and autumn. For an account of the battle of Thermopylæ at which Leonidas with a handful of men engaged the Perſian army, ſee SPARTA.

THESEA, in antiquity, feaſts celebrated by the Athenians in honour of Theſeus, conſiſting of ſports and games, with mirth and banquets. Such as were poor and unable to contribute to them were entertained at the public expence.

THESEUS, a famous hero of antiquity, ranked among the demigods, whoſe hiſtory is fabulous. He was the reputed ſon of Ægeus king of Athens. He threw Sciron, a cruel robber, down a precipice; faſtened Procruſtes tyrant of Attica to a bending pine, which being let looſe tore him aſunder; killed the Minotaur kept in the labyrinth by King Minos, in Crete; and by the aſſiſtance of that prince's daughter, Ariadne, who gave him a clue, eſcaped out of that labyrinth, and failed with his deliverer to the iſle of Naxos, where he had the ingratitude to leave her.

Theſeus afterwards overcame the Centaurs, ſubdued the Thebans, and defeated the Amazons. He aſſiſted his friend Pirithous in his expedition to the infernal regions to carry off Proſerpine; but was impriſoned by Pluto, till he was releaſed by Hercules. He is alſo ſaid to have eſtabliſhed the Iſthmean games, in honour of Neptune; to have united the twelve cities of Attica; and to have founded a republic there, 1236 B. C. Some time after, taking a voyage into Epirus, he was ſeized by Aidonius king of the Moloſſians; meanwhile Meneſtheus rendered himſelf maſter of Athens. But at length Theſeus being releaſed from priſon, retired to Scyros, where King Lycomedes cauſed him to be thrown from the top of a rock. Theſeus had ſeveral wives; the firſt of whom was Helena the daughter of Tyndarus; the ſecond, Hypolita queen of the Amazons; and the laſt, Phedra ſiſter to Ariadne, who puniſhed him for his infidelity to her ſiſter, by her inceſtuous paſſion for his ſon Hippolitus.

THESIS, a general poſition which a perſon advances, and offers to maintain. In taking degrees in univerſities, the candidates are generally obliged to write a theſis, which they muſt afterwards defend.

THESIUM, BASE FLUELLIN; a genus of plants belonging to the claſs of pentandria, and order of monogynia. See BOTANY *Index*.

THESPIS, a famous Greek tragic poet, and the firſt repreſenter of tragedy at Athens. He carried his troop from village to village in a waggon, from which they performed their pieces. Alceſtis was the firſt tragedy they performed at Athens, 536 B. C. See THEATRE.

THESSALIAN CHAIR, ſo called from Theſſaly, where chairs of this figure were moſt in uſe; it is recommended by Hippocrates * in place of a machine for reducing a recent luxation of the ſhoulder bone. The back of this chair is perpendicular to the ſeat, as Galen tells us; by which conſtruction it is diſtinguiſhed and accommodated to the operation.

THESSALY, a country of Greece, whoſe boundaries have been different at different periods. Properly ſpeaking, Theſſaly was bounded on the ſouth by the ſouthern parts of Greece, or Græcia Propria; eaſt, by the Ægean; north, by Macedonia and Mygdonia; and weſt, by Illyricum and Epirus. It was generally divided into four ſeparate provinces, Theſſaliotis, Pelaſgiotis, Iſtiæotis, and Phthiotis, to which ſome add Magneſia. It has been ſeverally called *Æmonia*, *Pelaſgicum*, *Argos*, *Hellas*, *Argeia*, *Dryopis*, *Pelaſgia*, *Pyrrhæa*, &c. The name of Theſſaly is derived from Theſſalus, one of its monarchs. Theſſaly is famous for a deluge which happened there in the age of Deucalion. Its mountains and cities are alſo celebrated, ſuch as Olympus, Pelion, Oſſa, Lariſſa, &c. The Argonauts were partly natives of Theſſaly. The inhabitants of the country paſſed for a treacherous nation, ſo that falſe money was called *Theſſalian coin*, and a perfidious action a *Theſſalian deceit*. Theſſaly was originally governed by kings, till it became ſubject to the Macedonian monarchs. The cavalry was univerſally eſteemed, and the people were ſuperſtitious and addicted to the ſtudy of magic and incantations. See *Lucan*, lib. vi. ver. 438, &c.; *Dionyſ*. 219; *Curt*. lib. iii. cap. 2.; *Ælian*, *Var. Hiſt*. lib. iii. cap. 1.; *Pauſ*. lib. iv. cap. 36. lib. x. cap. 1.; *Mela*, lib. ii. cap. 3.; *Juſtin*, lib. vii. cap. 6.; *Diod*. iv.

Lempriere's Dictionary.

Theſſaly is now called *Janna*, a province of European Turkey, bounded by Macedonia on the north, by the Archipelago on the eaſt, by Achaia or Livadia on the ſouth, and by Epirus on the weſt.

THETIS, in Pagan mythology, the wife of Oceanus, and the mother of Nereus and Doris, who were married to each other; and from this marriage ſprung the nymphs of the earth and ſea. Among the ſea nymphs there was one named *Thetis the Younger*, who excelled all the reſt in beauty, and for whom Jupiter conceived ſuch a paſſion, that he reſolved to eſpouſe her: but being informed by the Deſtinies that ſhe would bring forth a ſon who would riſe above his father, he married her to Peleus. To their nuptials all the gods and goddeſſes were invited except Diſcord, who, to be revenged for this contempt, threw a golden apple into the aſſembly, on which was engraven, *For the faireſt*. Juno, Pallas, and Venus, diſputed for this apple; but Paris being choſen to decide the difference, adjudged it to Venus. From this marriage of Thetis and Peleus ſprung Achilles.

THEURGY, θεουργια, a name which the ancients gave to that ſacred part of magic which we ſometimes call *white magic*, or the *white art*.

The word is formed from Θεος, "God," and εργον, "work;" q. d. the art of doing divine things, or things which God alone can do: or the power of working extraordinary and ſupernatural things, by invoking the names

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* *Lib. de Art.*

names of God, ſaints, angels, &c. Accordingly, thoſe who have written of magic in general, divide it into three parts: the firſt whereo is called *theurgy*, as operating by divine or celeſtial means; the ſecond, *natural magic*, performed by the powers of nature; and the third, comprehending *necromancy*, *ſorcery*, and *witchcraft* or *magic*, performed by the aſſiſtance of demons or departed men. See MAGIC.

THIBET. See TIBET.

THIGH. See ANATOMY, Nº 58.

THINKING, a general name for any act or operation of the mind. See METAPHYSICS.

THIRLAGE. See LAW, Nº clxx. 12—18.

THIRST, an uneaſy ſenſation ariſing from a deficiency of the ſaliva to moiſten the inward parts of the mouth. Hence ariſes a ſtrong deſire for drink; and thirſt is a ſymptom generally attending fevers of all kinds.—Thirſt is beſt allayed by acids; water kept a while in the mouth, then ſpit out, and repeated as required; a bit of bread chewed with a little water, which latter may be gradually ſwallowed; if the perſon is very hot, brandy is the beſt for holding in the mouth, but ſhould be ſpit out again: except in fevers, large draughts of cold water are hurtful.

Preſervation againſt Hunger and THIRST. See HUNGER.

THISTLE, a name applied to different genera and ſpecies of plants belonging chiefly to the ſyngeneſia claſs. See CARDUUS, ONOPORDUM, SERRATULA, SONCHUS, and alſo DIPSACUS, BOTANY *Index*.

Order of the THISTLE, or *of St Andrew*, a military order of knighthood in Scotland, the riſe and inſtitution of which is variouſly related by different authors. Leſley biſhop of Roſs reports, that the night before the battle between Athelſtan king of Northumberland and Hungus king of the Picts, a bright croſs, in form of that whereon St Andrew (the tutelar ſaint of Scotland) ſuffered martyrdom, appeared to Hungus; who having gained the victory, ever after bore the figure of that croſs on his banners. Others aſſert, that Achaius king of Scotland firſt inſtituted this order, after having made the famous league offenſive and defenſive with Charlemagne king of France. But although the thiſtle had been acknowledged as the ſymbol of the kingdom of Scotland from the reign of Achaius, yet ſome refer the beginning of this order to Charles VII. of France. Others place the foundation of it as low as the year 1500.

The chief and principal enſign is a gold collar compoſed of thiſtles and ſprigs of rue interlinked with amulets of gold, having pendent thereto the image of St Andrew with his croſs, and the motto, NEMO ME IMPUNE LACESSET. "No body ſhall provoke me with impunity."

The ordinary or common enſign worn by the knights is a ſtar of four ſilver points, and over them a green circle, bordered and lettered with gold, containing the ſaid motto, and in the centre is a thiſtle; all which is embroidered on their left breaſt, and worn with the collar, with a green ribband over the left ſhoulder, and brought under the right arm; pendent thereto is the image of St Andrew, with his croſs, in a purple robe, within an oval of gold enamelled vert, with the former motto; but ſometimes they wear, encircled in the ſame manner, a thiſtle crowned.

About the time of the Reformation, this order was dropped, till James II. of Great Britain reſumed it, by creating eight knights. The Revolution unſettled it again; and it lay neglected, till Queen Anne, in 1703, reſtored it to the primitive deſign, of twelve knights of St Andrew.

THLAPSI, BASTARD-CRESS, or *mithridate-muſtard*; a genus of plants belonging to the claſs of tetradynamia. See BOTANY *Index*.

THOLOUSE. See TOULOUSE.

THOMÆANS, THOMISTS. See *CHRISTIANS of St Thomas*.

THOMAS AQUINAS. See AQUINAS.

St THOMAS'S *Day*, a feſtival of the Chriſtian church, obſerved on December 21. in commemoration of St Thomas the apoſtle.

St THOMAS *of Canterbury's Day*, a feſtival of the Romiſh church, obſerved on December 29. in memory of Thomas Becket archbiſhop of Canterbury, who was murdered, or, as the Romaniſts ſay, martyred, in the reign of King Henry II.

THOMAS *the Reymour*, called alſo *Thomas Lermont*, and *Thomas of Erceldon*, was born at Erceldon, a village near Melroſe in Tweedale, in what year is uncertain; but he was an old man when Edward I. was carrying on war in Scotland.

The character of Lermont as a prophet, and which was common to him with Linus, Orpheus, and other early poets in many countries, aroſe, if we may believe Mackenyie in his Lives of Scottiſh Writers, from his having conferences with Eliza, a nun and propheteſs at Haddington. Lermont put her predictions into verſe, and thus came in for his ſhare of the prophetic ſpirit. None of theſe ancient prophecies now remain; but the following, which pretends to be one of them, is given from a manuſcript of the time of Edward I. or II. The counteſs of Dunbar is the lady famous for the defence of her caſtle againſt the Engliſh. Her proper title was *Counteſs of March*; but it was common in theſe times to ſtyle a nobleman from his chief reſidence. Thus Gilbert Strongbow, earl of Pembroke, is called *Earl of Striguil*, from his reſidence at Striguil-caſtle, near Chepſtow, Monmouthſhire, &c.

Pinkerton's Account of Scottiſh Poets.

La Counteſſe de Donbar demande a Thomas de Eſſedoune, quant la guere d'Eſcoce prendreit fyn. E yl la repoundy, et dyt.

When man as mad a kyng of a capped mon.
When mon is levere other mons thyng than is owen.
When londe thouys foreſt, and foreſt ys felde.
When hares kendles othe herſton.
When Wyt and Wille werres togedere.
When mon makes ſtables of kyrkes; and ſteles caſtles wyth ſtyes.
When Rokeſbourh nys no burgh; ant market is at Forwyleye.
When the alde is gan, and the newe is come that doue noht.
When Bambourne ys donged with dede men.
When men ledes men in ropes to buyen ant to ſellen.
When a quarter of whaty whete is chaunged for a colt of ten markes.
When prude prikes, ant pees is leyd in priſoun.
When a Scot ne may hym hude aſe hare in forme, that the Englyſh ne ſhal hym fynde.

When ryht ant wrong aſtente the togedere.
When laddes weddeth lovedies.
When Scottes flen ſo faſte, that for faute of ſhip, hy drouneth hemſelve.
When ſhal this be ?
Nouther in thyne tyme, ne in myne.
Ah comen, ant gone,
Withinne twenty wynter ant on.

In fact, the prophecies of Lermont appear to have been merely traditional ; nay, it ſeems doubtful if he ever pretended to ſuch folly, notwithſtanding Mackenyie's ſtory of Eliza. The reverence of the people for a learned and reſpectable character ſeems to have been the ſole foundation of Thomas's claim to prophecy. But, in the 16th century, prophecies were made, and aſcribed to him, as well as others given to Bede, Merlin, &c. (A). They were printed at Edinburgh, 1615 ; reprinted 1680, and 1742.

THOMISM. See Aquinas.

THOMSON, James, an excellent Britiſh poet, the ſon of a Scotch divine, was born in the ſhire of Roxburgh in 1700, and was educated in the univerſity of Edinburgh with a view to the miniſtry. But his genius inclining him to the ſtudy of poetry, which he ſoon found would be incompatible with that of theology, or at leaſt might prevent his being provided for in that way in his own country, he relinquiſhed his views of engaging in the ſacred function, and repaired to London in conſequence of ſome encouragement which he had received from a lady of quality there, a friend of his mother.

The reception he met with wherever he was introduced, emboldened him to riſk the publication of his excellent poem on Winter.—This piece was publiſhed in 1726 ; and from the univerſal applauſe it met with, Mr Thomſon's acquaintance was courted by people of the firſt taſte and faſhion. But the chief advantage which it procured him was the acquaintance of Dr Rundle, afterward biſhop of Derry, who introduced him to the late lord chancellor Talbot ; and ſome years after, when the eldeſt ſon of that nobleman was to make his tour on the continent, Mr Thomſon was choſen as a proper companion for him. The expectations which his Winter had raiſed, were fully ſatisfied by the ſucceſſive publications of the other ſeaſons ; of Summer, in the year 1727 ; of Spring, in the following year ; and of Autumn, in a quarto edition of his works, in 1730. Beſide the Seaſons, and his tragedy of Sophoniſba, written and acted with applauſe in the year 1729, he had, in 1727, publiſhed his poem to the memory of Sir Iſaac Newton, with an account of his chief diſcoveries ; in which he was aſſiſted by his friend Mr Gray, a gentleman well verſed in the Newtonian philoſophy. That ſame year the reſentment of our merchants, for the interruption of their trade by the Spaniards in America, running very high, Mr Thomſon zealouſly took part in it, and wrote his Britannia, to rouſe the nation to revenge.

With the honourable Charles Talbot, our author viſited moſt of the courts in Europe, and returned with his views greatly enlarged ; not only of exterior nature and the works of art, but of human life and manners, and of the conſtitution and policy of the ſeveral ſtates, their connections, and their religious inſtitutions. How particular and judicious his obſervations were, we ſee in his poem on Liberty, begun ſoon after his return to England. We ſee at the ſame time to what a high pitch his care of his country was raiſed, by the compariſons he had all along been making of our happy government with thoſe of other nations. To inſpire his fellow-ſubjects with the like ſentiments, and ſhow them by what means the precious freedom we enjoy may be preſerved, and how it may be abuſed or loſt, he employed two years in compoſing that noble work, upon which he valued himſelf more than upon all his other writings. On his return to England with Mr Talbot (who ſoon after died), the chancellor made him his ſecretary of briefs ; a place of little attendance, ſuiting his retired indolent way of life, and equal to all his wants. From this office he was removed, when death, not long after, deprived him of his noble patron. He then found himſelf reduced to a ſtate of a precarious dependence. In this ſituation, having created ſome few debts, and his creditors finding that he had no longer any certain ſupport, became inexorable ; and imagined by confinement to force that from his friends, which his modeſty would not permit him to aſk. One of theſe occaſions furniſhed Quin, the celebrated actor, with an opportunity of diſplaying the natural goodneſs of his heart, and the diſintereſtedneſs of his friendſhip. Hearing that Thomſon was confined in a ſpunging houſe for a debt of about 70l. he repaired to the place ; and, having inquired for him, was introduced to the bard. Thomſon was a good deal diſconcerted at ſeeing Quin, as he had always taken pains to conceal his wants ; and the more ſo, as Quin told him he was come to ſup with him. His anxiety upon this head was however removed, upon Quin's informing him, that, as he ſuppoſed it would have been inconvenient to have had the ſupper dreſſed in the place they were in, he had ordered it from an adjacent tavern ; and, as a prelude, half a dozen of claret was introduced. Supper being over, and the bottle circulating pretty briſkly, Quin ſaid, " It is time now we ſhould balance accounts." This aſtoniſhed Thomſon, who imagined he had ſome demand upon him ; but Quin perceiving it, continued, " Mr Thomſon, the pleaſure I have had in peruſing your works I cannot eſtimate at leſs than a hundred pounds, and I inſiſt upon now acquitting the debt." On ſaying this, he put down a note of that value, and took his leave, without waiting for a reply.

The profits ariſing from his works were not inconſiderable ; his tragedy of Agamemnon, acted in 1738, yielded a good ſum. But his chief dependence was upon the prince of Wales, who ſettled on him a handſome allowance, and honoured him with many marks of particular favour. Notwithſtanding, this, however, he was

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(A) Sibilla and Baniſter Anglicus are mentioned in the time of Edward IV. (MSS. Cot. Dom. A. IX.) A long Latin prophecy of Bridlington is there given. Waldhave and Eltraine ſeem alſo Engliſh prophets. In the whole collection, therefore, Thomas is the only Scottiſh one.

was refuſed a licence for his tragedy of Edward and Eleanora, which he had prepared for the ſtage in the year 1736, for ſome political reaſons. Mr Thomſon's next performance was the Maſque of Alfred, written in the year 1740 jointly with Mr Mallet, by the command of the prince of Wales, for the entertainment of his royal highneſs's court at Clifden, his ſummer reſidence.

Mr Thomſon's poem, entitled the Caſtle of Indolence, was his laſt work publiſhed by himſelf; his tragedy of Coriolanus being only prepared for the theatre, when a fatal accident robbed the world of one of the beſt of men and beſt of poets. He would commonly walk the diſtance between London and Richmond (where he lived) with any acquaintance that offered, with whom he might chat and reſt himſelf, or perhaps dine by the way. One ſummer evening being alone in his walk from town to Hammerſmith, he had over-heated himſelf, and in that condition imprudently took a boat to carry him to Kew; apprehending no bad conſequence from the chill air on the river, which his walk to his houſe, towards the upper end of Kew-lane, had always hitherto prevented. But now the cold had ſo ſeized him, that the next day he was in a high fever. This, however, by the uſe of proper medicines, was removed, ſo that he was thought out of danger; till the fine weather having tempted him to expoſe himſelf once more to the evening dews, his fever returned with violence, and with ſuch ſymptoms as left no hopes of a cure. His death happened on the 27th of Auguſt 1748.

Mr Thomſon had improved his taſte upon the fineſt originals, ancient and modern. The autumn was his favourite ſeaſon for poetical compoſition, and the deep ſilence of the night he commonly choſe for his ſtudies. The amuſement of his leiſure hours were civil and natural hiſtory, voyages, and the beſt relations of travellers. Though he performed on no inſtrument, he was paſſionately fond of muſic, and would ſometimes liſten a full hour at his window to the nightingales in Richmond gardens; nor was his taſte leſs exquiſite in the arts of painting, ſculpture, and architecture. As for the more diſtinguiſhing qualities of his mind and heart, they beſt appear in his writings. There his devotion to the Supreme Being, his love of mankind, of his country, and friends, ſhine out in every page; his tenderneſs of heart was ſo unbounded, that it took in even the brute creation. It is not known, that through his whole life he ever gave any perſon a moment's pain, either by his writings or otherwiſe. He took no part in the political ſquabbles of his time, and was therefore reſpected and left undiſturbed by both ſides. Theſe amiable virtues did not fail of their due reward; the applauſe of the public attended all his productions, and his friends loved him with an enthuſiaſtic ardour.

"As a writer (ſays Dr Johnſon), he is entitled to one praiſe of the higheſt kind; his mode of thinking, and of expreſſing his thoughts, is original. His blank verſe is no more the blank verſe of Milton, or of any other poet, than the rhymes of Prior are the rhymes of Cowley. His numbers, his pauſes, his diction, are of his own growth, without tranſcription, without imitation. He thinks in a peculiar train, and thinks always as a man of genius; he looks round on Nature and on life with the eye which Nature beſtows only on a poet; the eye that diſtinguiſhes, in every thing repreſented to its view, whatever there is on which imagination can delight to be detained, and with a mind that at once comprehends the vaſt, and attends to the minute. The reader of the Seaſons wonders that he never ſaw before what Thomſon ſhews him, and that he never yet has felt what Thomſon impreſſes."

Johnſon's Lives of the Poets.

His teſtamentary executors were the lord Lyttelton, whoſe care of our poet's fortune and fame ceaſed not with his life; and Mr Mitchell, a gentleman equally noted for the truth and conſtancy of his private friendſhip, and for his addreſs and ſpirit as a public miniſter. By their united intereſts, the orphan play of Coriolanus was brought on the ſtage to the beſt advantage; from the profits of which, and the ſale of manuſcripts and other effects, a handſome ſum was remitted to his ſiſters. His remains were depoſited in the church of Richmond, under a plain ſtone, without any inſcription. A handſome monument was erected to him in Weſtminſter abbey in the year 1762, the charge of which was defrayed by the profits ariſing from a ſplendid edition of all his works in 4to; Mr Millar the bookſeller, who had purchaſed all Mr Thomſon's copies, giving up his property on this grateful occaſion. A monument has alſo been erected to him at the place of his birth.

THOR, the eldeſt and braveſt of the ſons of Odin and Frea, was, after his parents, the greateſt god of the Saxons and Danes while they continued heathens. They believed, that Thor reigned over all the aerial regions, which compoſed his immenſe palace, conſiſting of 540 halls; that he launched the thunder, pointed the lightning, and directed the meteors, winds, and ſtorms. To him they addreſſed their prayers for favourable winds, refreſhing rains, and fruitful ſeaſons; and to him the fifth day of the week, which ſtill bears his name, was conſecrated.

Henry's Hiſtory of Great Britain, vol. iii part 4.

THORAX. See ANATOMY.

WHITE or *HAW* THORN. See CRATÆGUS, BOTANY *Index*.

THORN, a town of Poland, in Regal Pruſſia, and in the palatinate of Culm. It was formerly a Hanſeatic town, and ſtill enjoys great privileges; is large and well fortified; but part of the fortifications, and a great number of houſes, were ruined by the Swedes, in 1703. It is ſeated on the Viſtula, and contains 10,000 inhabitants. E. Long. 18. 42. N. Lat. 53. 6.

THORNBACK. See RAIA, ICHTHYOLOGY *Index*.

THORNHILL, SIR JAMES, an eminent Engliſh painter, was born in Dorſetſhire in 1676, of an ancient family; but was conſtrained to apply to ſome profeſſion by the diſtreſſes of his father, who had been reduced to the neceſſity of ſelling his family eſtate. His inclination directed him to the art of painting; and on his arrival at London he applied to his uncle, the famous Dr Sydenham, who enabled him to proceed in the ſtudy of the art under the direction of a painter who was not very eminent. However, the genius of Thornhill made ample amends for the inſufficiency of his inſtructor, and by a happy application of his talents he made ſo great a progreſs, that he gradually roſe to the higheſt reputation.

Dictionary of Painters.

His genius was well adapted to hiſtorical and allegorical compoſitions; he poſſeſſed a fertile and fine invention; and he ſketched his thoughts with great eaſe, freedom, and ſpirit. He excelled alſo equally in portrait,

trait, perſpective, and architecture; ſhewed an excellent taſte for deſign, and had a free and firm pencil. Had he been ſo fortunate as to have ſtudied at Rome and Venice, to acquire greater correctneſs at the one, and a more exact knowledge of the perfection of colouring at the other, no artiſt among the moderns might perhaps have been his ſuperior. Neverthelefs, he was ſo eminent in many parts of his profeſſion, that he muſt for ever be ranked among the beſt painters of his time; and his performances in the dome of St Paul's church at London, in the hoſpital at Greenwich, and at Hampton-court, are ſuch public proofs of his merit as will convey his name to poſterity with great honour.

This painter lived in general eſteem; he enriched himſelf by the excellence of his works; was appointed ſtate-painter to Queen Anne, from whom he received the honour of knighthood; had the ſingular ſatisfaction to repurchaſe his family eſtate; and was ſo much diſtinguiſhed as to be elected one of the members of parliament. He died in 1732.

THOROUGH-WAX, in *Botany*. See BUPLEURUM.

THOTH, or THEUT, (called by the Phœnicians *Taaut*, by the Greeks *Hermes*, and by the Romans *Mercury*), was a Phœnician of very ſuperior talents, and one of the civilizers of mankind. He was prime miniſter to Oſiris, whom, after his death, he deified; and he was himſelf deified by his countrymen the Egyptians, for the benefits that he had rendered to the human race. See MERCURY, MYTHOLOGY, N° 34. and POLYTHEISM, N° 18.

THOUGHT, a general name for all the ideas conſequent on the operations of the mind, and even on the operations themſelves. See METAPHYSICS.

THOUGHT, in compoſition. See ORATORY, Part I. and II.

THOUINIA, a genus of plants belonging to the claſs of diandria, and order of monogynia. See BOTANY *Index*.

THRACE, a country very frequently mentioned by the Greek and Latin writers, deriving its name, according to Joſephus, from Tiras one of the ſons of Japhet. It was bounded on the north by Mount Hæmus; on the ſouth, by the Ægean ſea; on the weſt, by Macedon and the river Strymon; and on the eaſt, by the Euxine ſea, the Helleſpont, and the Propontis.—The Thracian Cherſoneſus is a peninſula incloſed on the ſouth by the Ægean ſea, on the weſt by the gulf of Melas, and on the eaſt by the Helleſpont; being joined on the north to the continent by a neck of land about 37 furlongs broad. The inland parts of Thrace are very cold and barren, the ſnow lying on the mountains the greateſt part of the year; but the maritime provinces are productive of all ſorts of grain and neceſſaries for life; and withal ſo pleaſant, that Mela compares them to the moſt fruitful and agreeable countries of Aſia.

The ancient Thracians were deemed a brave and warlike nation, but of a cruel and ſavage temper; being, according to the Greek writers, ſtrangers to all humanity and good nature. It was to the Thracians, however, that the Greeks were chiefly indebted for the polite arts that flouriſhed among them; for Orphæus, Linus, Muſæus, Thamyris, and Eumolpus, all Thracians, were the firſt, as Euſtathius informs us, who charmed the inhabitants of Greece with their eloquence and melody, and perſuaded them to exchange their fierceneſs for a ſociable life and peaceful manners; nay, great part of Greece was anciently peopled by Thracians. Tereus, a Thracian, governed at Daulis in Phocis, where the tragical ſtory of Philomela and Progne was acted. From thence a body of Thracians paſſed over to Eubœa, and poſſeſſed themſelves of that iſland. Of the ſame nation were the Aones, Tembices, and Hyanthians, who made themſelves maſters of Bœotia: and great part of Attica itſelf was inhabited by Thracians, under the command of the celebrated Eumolpus. It is not therefore without the utmoſt ingratitude and injuſtice that the Greeks ſtyle them *Barbarians*, ſince to them chiefly they were indebted both for the peopling and poliſhing of their country.

Thrace was anciently divided into a number of petty ſtates, which were firſt ſubdued by Philip of Macedon. On the decline of the Macedonian empire, the country fell under the power of the Romans. It continued under ſubjection to them till the irruption of the Turks, in whoſe hands it ſtill remains.

THRASHING, in *Agriculture*, the operation by which corn is ſeparated from the ſtraw. This operation is performed in a variety of ways, ſometimes by the feet of animals, ſometimes by a flail, and ſometimes by a machine.

The moſt ancient method of ſeparating the corn from the ſtraw was by the hoofs of cattle or horſes. This was practiſed by the Iſraelites, as we find from the books of Moſes; it was alſo common among the Greeks and Romans [*]. Flails and thraſhing machines were alſo not uncommon among theſe nations [†]. The flail which was uſed by the Romans, called *baculus*, *fuſtis*, or *pertica*, was probably nothing more than a cudgel or pole. The thraſhing machine, which was called *tribula* or *tribulum*, and ſometimes *traha*, was a kind of ſledge made of boards joined together, and loaded with ſtone or iron. Horſes were yoked to this machine, and a man was ſeated upon it to drive them over the ſheaves of corn.

Different methods are employed in different countries for ſeparating the corn from the ſtalk. In the greateſt part of France the flail is uſed; but in the ſouthern diſtricts it is generally performed by the feet of animals. Animals are alſo uſed for the ſame purpoſe in Spain, in Italy, in the Morea, in the Canaries, in China, and in the vicinity of Canton, where the flail is alſo ſometimes uſed. It appears that in hot climates the grains do not adhere ſo firmly to the ſtalk as in cold countries, and therefore may be more eaſily ſeparated. This will explain the reaſon why animals are ſo frequently employed in hot countries for treading out the corn; whereas in cold climates we know they are ſeldom tried, and have no reaſon to ſuppoſe that they would anſwer the purpoſe. In the Iſle of France in Africa, rice and wheat are thraſhed with poles, and maize with ſticks; for it has not been poſſible to teach the negroes the uſe of the flail.

The animals uſed for treading out corn are, oxen, cows, horſes, mules, and even aſſes when the quantity is not great. The operation is performed in this manner: The ſheaves, after being opened, are ſpread in ſuch a manner that the ears of the corn are laid as much uppermoſt as poſſible, and a man, ſtanding in the centre, holds the halters of the cattle, which are made to trot round as in a manege; whilſt other men with

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[*] *Pliny*, xviii. 30. *Virgil*, Georg. iii. 132. *Col.* ii. 21. *Tibull.* i. 5. 21.

[†] Iſaiah xviii. 27. *Homer*, Il., xx. 495.

forks ſhake the ſtraw up from time to time, and the cattle are trotted over it again and again till they have beaten out all the grain. This method is expeditious enough; but beſides bruiſing a conſiderable quantity of corn, it requires a great many cattle, and injures the legs of the horſes and mules, which are preferred before cows and oxen for this work.

The flail is undoubtedly a much better inſtrument for thraſhing corn than the feet of animals, for it ſeparates the grain from the ſtraw and huſks both more effectually and more expeditiouſly; yet it is liable to many objections. It is a very laborious employment, too ſevere indeed even for a ſtrong man; and as it is uſually the intereſt of the thraſher rather to thraſh much than to thraſh clean, a good deal of corn will generally be left upon the ſtraw. It is therefore an object of great importance in huſbandry to procure a proper machine for ſeparating the corn from the ſtraw.

The firſt thraſhing machine attempted in modern times, of which we have received any account, was invented in Edinburgh by Mr Michael Menzies about the year 1732. It conſiſted of a number of inſtruments like flails, fixed in a moveable beam, and inclined to it at an angle of ten degrees. On each ſide of the beam in which the flails were fixed, floors or benches were placed for ſpreading the ſheaves on. The flails were moved backwards and forwards upon the benches by means of a crank fixed on the end of an axle, which made about 30 revolutions in a minute.

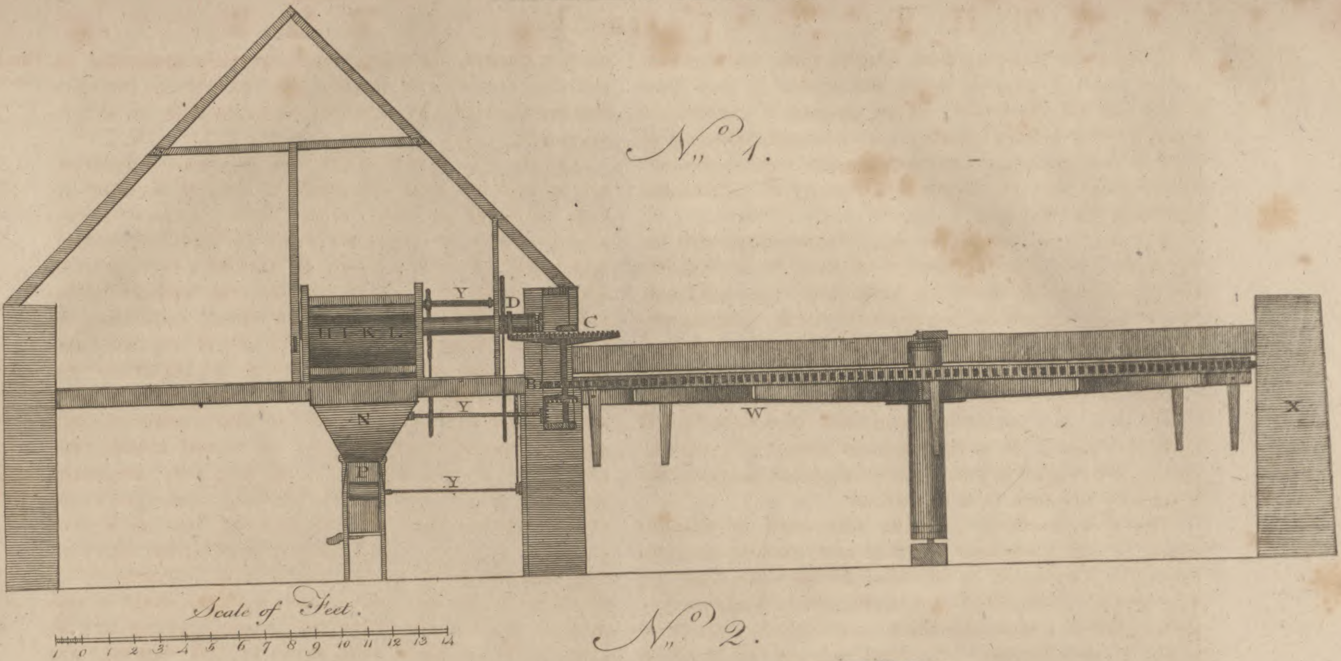
The ſecond thraſhing machine was invented by Mr Michael Stirling, a farmer in the pariſh of Dunblane, Perthſhire. Of this diſcovery we have received a very accurate and authentic account from his ſon, the reverend Mr Robert Stirling miniſter of Crieff.

It is an old proverb, that neceſſity is the mother of invention. This was verified on the preſent occaſion. Beſides his ordinary domeſtic ſervants, Mr M. Stirling had occaſion ſometimes to hire an additional number to thraſh out his grain, and frequently found it difficult to procure ſo many as he needed. This naturally led him to reflect whether the operation of thraſhing could not eaſily be performed by machinery. Accordingly, ſo early as the year 1753, under the pretence of joining in the amuſements of his children, he formed in miniature a water mill, in which two iron ſprings, made to riſe and fall alternately, repreſented the motion of two flails, by which a few ſtalks of corn put under them might be ſpeedily thraſhed. This plan he executed on a ſcale ſufficiently large within two years after, making the ſprings about ten feet long, each of which had one end firmly ſcrewed into a ſolid plank, and the other terminated in a round batoon of ſolid iron, two feet long and above an inch in diameter. Under theſe the ſheaves were conveyed gradually forward in a narrow channel or trough, by paſſing between two indented horizontal cylinders, ſimilar to thoſe now uſed in the moſt of the thraſhing mills in that part of the country, and called *feeders*. In this manner the thraſhing was executed completely, and with conſiderable rapidity; but as the operation was performed on a low floor, and no method contrived for carrying off the ſtraw, the accumulation of it produced ſuch confuſion, and the removal of it was attended with ſuch danger, that this ſcheme was very ſoon entirely abandoned. The mortification ariſing from diſappointment, and eſpecially the ſcoffs of his neighbours, for what was univerſally accounted an abſurd and ridiculous attempt, ſerved only to ſtimulate the exertions of the inventor to accompliſh his deſigns on another plan.

Laying aſide therefore the iron ſprings with the feeders, and all the apparatus adapted to them, he retained only an outer or water wheel, with an inner or cog wheel moving on the ſame axle: to this inner wheel, which had 48 teeth or cogs, he applied a vertical trundle or pinion, with ſeven notches, the axle of which paſſed through a floor above the wheel, and having its upper pivot ſecured in a beam ſix feet above that floor. At the diſtance of three feet three inches above the floor two ſtraight pieces of ſquared wood, each four feet long, paſſed through the axle of the trundle at right angles, forming four arms, to be moved round horizontally. To the extremities of theſe arms were fixed four iron plates, each 20 inches long, and eight broad at the end next the arms, but tapering towards a point at the other end. This large horizontal fly, conſtituting four thraſhers, was incloſed within a wooden cylindrical box three feet and a half high and eight in diameter. On the top of the box was an opening or port (two or three ports were made at firſt, but one was found ſufficient) eight inches wide, and extending from the circumference a foot and a half towards its centre, through which the corn ſheaves deſcended, being firſt opened and laid one by one on a board with two ledges gently declining towards the port; on which board they were moderately preſſed down with a boy's hand, to prevent them from being too haſtily drawn in by the repeated ſtrokes of the thraſhers. Within the box was an inclined plane, along which the ſtraw and grain fell down into a wide wire riddle two feet ſquare, placed immediately under a hole of nearly the ſame ſize. The riddle received a jerk at every revolution of the ſpindle from a knob placed on the ſide of it, and was inſtantly thruſt backward by a ſmall ſpring preſſing it in the oppoſite direction. The ſhort ſtraw, with the grain and chaff which paſſed through the wide riddle, fell immediately into an oblong ſtrait riddle, which hung with one end raiſed and the other depreſſed, and was moved by a contrivance equally ſimple as the other; and having no ledge at the lower end, the long chaff which could not paſs through the riddle dropped from thence to the ground; while the grain and moſt of the chaff falling through the riddle into a pair of common barn-fanners that ſtood under it on the ground floor, the ſtrong grain, the weak, and the chaff, were all ſeparated with great exactneſs. The fanners were moved by a rope or band running circuitouſly in a ſhallow niche cut on the circumference of the cog-wheel. The ſtraw collected gradually in the bottom of the box over the wide riddle, and through an opening two and a half feet wide, and as much in height, left in that ſide of the box neareſt the brink of the upper floor, was drawn down to the ground with a rake by the perſon or perſons employed to form it into ſheaves or rolls.

Such was the thraſhing mill invented by Mr Michael Stirling, which, after various alterations and improvements he completed in the form now deſcribed, A. D. 1758. By experiment it was found that four bolls of oats, Linlithgow meaſure, could be thraſhed by it in 25 minutes. From that period he never uſed a common flail in thraſhing, except for humbling or bearding barley.

Nº 1.



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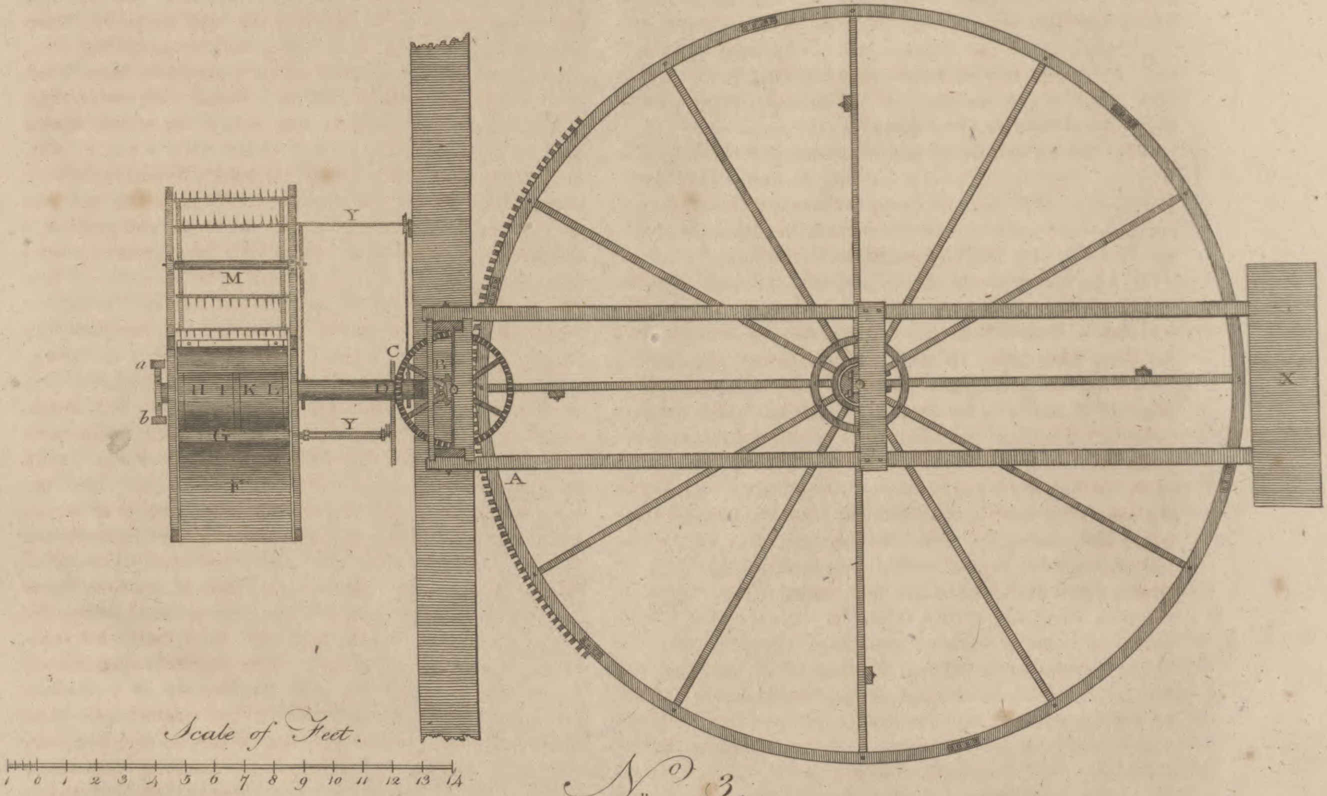

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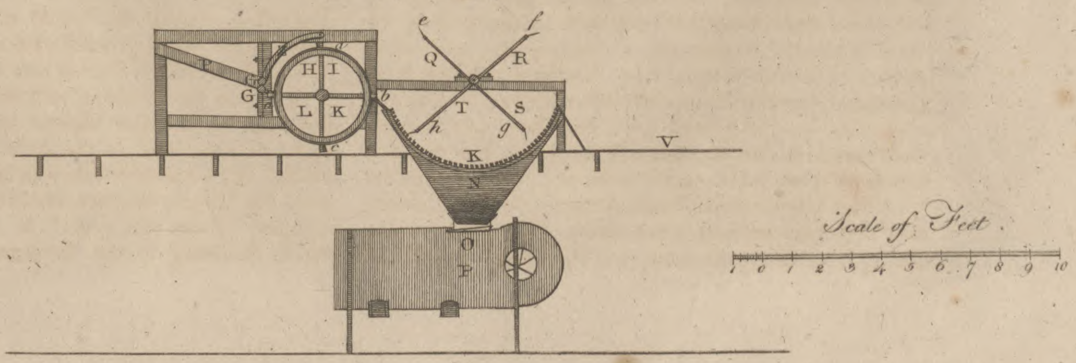

W. Train Sculpt

Thraſhing.

ley. In every other kind of grain he performed the whole operation of thraſhing with the mill; and continued always to uſe it till 1772, when he retired from buſineſs, and his thraſhing mill became the property of his ſecond ſon, who continues to uſe it with equal advantage and ſatisfaction. Several machines were conſtructed on the ſame plan, particularly one near Stirling, under Mr Stirling's direction, for Mr Moir of Leckie, in 1765, which, we underſtand, has been uſed ever ſince, and gives complete ſatisfaction to the proprietor. There was another erected in 1778 by Mr Thomas Keir (in the pariſh of Muthil and county of Perth), who has contrived a method of bearding barley with it: and by the addition of a ſmall ſpindle with ſhort arms contiguous to the front of the box, and moved by a band common to it and the great ſpindle to which it is parallel, the ſtraw is ſhaken and whirled out of the box to the ground. That this machine did not come immediately into general uſe, was owing partly to the ſmallneſs of the farms in that part of the country, whoſe crops could eaſily be thraſhed by the few hands neceſſarily retained on them for other purpoſes; and chiefly to an apprehenſion that the machine could only be moved by water; an apprehenſion which experience proves to be entirely groundleſs. The machine however, was, ingenious, and did great credit to the worthy inventor, and certainly deſerved a better fate than it was deſtined to undergo.

A third thraſhing mill was invented in 1772, by two perſons nearly about the ſame time, and upon the ſame principles. The inventors were, Mr Alderton who lived near Alnwick, and Mr Smart at Wark in Northumberland. The operation was performed by rubbing. The ſheaves were carried round between an indented drum of about ſix feet diameter, and a number of indented rollers arranged round the circumference of the drum, and attached to it by means of ſprings; ſo that while the drum revolved, the fluted rollers rubbed the corn off from the ſtraw by rubbing againſt the flutings of the drum. But as a conſiderable quantity of the grain was bruiſed in paſſing between the rollers, the machine was ſoon laid aſide.

In 1776 an attempt was made by Mr Andrew Meikle, an ingenious millwright in the pariſh of Tyningham, Eaſt Lothian, to conſtruct a new machine upon the principles which had been adopted by Mr Menzies already mentioned. This conſiſted in making joints in the flails, which Mr Menzies had formed without any. But this machine, after much labour and expence, was ſoon laid aſide, on account of the difficulty of keeping it in repair, and the ſmall quantity of work performed, which did not exceed one boll or ſix Wincheſter buſhels of barley per hour.

Some time after this, Mr Francis Kinloch, then junior of Gilmerton, having viſited the machine invented in Northumberland, attempted an improvement upon it. He incloſed the drum in a fluted cover; and inſtead of making the drum itſelf fluted, he fixed upon the outſide of it four fluted pieces of wood, which by means of ſprings could be raiſed a little above the circumference of the drum, ſo as to preſs againſt the fluted covering, and thus rub off the ears of corn as the ſheaves paſſed round between the drum and the fluted covering. But not finding this machine to anſwer his expectation (for it bruiſed the grain in the ſame manner as the Northumberland machine did), he ſent it to Mr Meikle, that he might, if poſſible, rectify its errors.

Thraſhing.

Mr Meikle, who had long directed his thoughts to this ſubject, applied himſelf with much ardour and perſeverance to the improvement and correction of this machine; and after ſpending a good deal of time upon it, found it was conſtructed upon principles ſo erroneous, that to improve it was impracticable.

At length, however, Mr Meikle's own genius invented a model, different in principle from the machines which had already been conſtructed. This model was made in the year 1785; and in the following year the firſt thraſhing machine on the ſame principles was erected in the neighbourhood of Alloa, in the county of Stirling, by Mr George Meikle the ſon of the inventor. This machine anſwered completely the wiſhes of Mr Stein, the gentleman for whom it was erected, who gave the moſt ample teſtimony of his ſatisfaction both to the inventor and to the public. The fame of this diſcovery ſoon ſpread over the whole country, and a great many farmers immediately applied to Mr Meikle, deſiring to have thraſhing mills erected on their farms. The diſcovery, it appeared, would be profitable, and it was reaſonable that the inventor ſhould enjoy the profits of his invention. He accordingly applied for a patent; which, after conſiderable expence, ariſing from the oppoſition of ſome perſons, who claimed a ſhare in the diſcovery, was granted.—Theſe machines are now becoming very common in many parts of Scotland, and are increaſing very conſiderably in number every year over all the united kingdom.

We will now endeavour to deſcribe this machine in its moſt improved ſtate; which is ſo ſimple that with the aſſiſtance of a plate, exhibiting the plan of elevation, fig. 1. the ground plan, fig. 2. and the 3d ſhowing its eſſential parts in a diſtinct manner, we hope it will be eaſily underſtood by all our readers who have not had an opportunity of ſeeing it. The power employed for turning that part of the machine which ſeparates the corn from the ſtraw is produced by four wheels (when moved by horſes), the teeth of which move in one another and turn the drum, on which four ſcutchers are fixed. The ſheaves are introduced between two fluted rollers, which hold them firm, and draw them in gradually, while the ſcutchers ſtrike off the grain from the ſtraw as it paſſes through. This will ſuffice for a general idea of this machine. We will now be more particular.

Plate DXXXV.

Fig. 1. and 2.

The large ſpur-wheel A, fig. 1. and 2. which has 276 cogs, is horizontal, and moves the pinion B, which has 14 teeth. The pinion B moves the crown-wheel C, which has 84 teeth; the wheel C moves a ſecond pinion D, which has 16 teeth; and the pinion D moves the drum HIKL. The drum is a hollow cylinder three feet and a half diameter, and placed horizontally; on the outſide of which the ſcutchers are fixed by ſtrong ſcrew bolts. The ſcutchers conſiſt of four pieces of wood, faced on one ſide with a thin plate of iron, placed at an equal diſtance from each other, and at right angles to the axis of the drum.

Fig. 3.

The ſheaves are ſpread on an inclined board F, fig. 3. from which they are introduced between two fluted rollers GG made of caſt iron, about three inches and a half in diameter, and making about 35 revolutions in a minute. As theſe rollers are only about three quarters of an inch diſtant from the ſcutchers or leaves of the drum HIKL, they ſerve to hold the ſheaves faſt, while the ſcutchers *a*, *b*, *c*, *d*, moving with prodigious velocity, ſeparate the grain completely from the ſtraw, and at the ſame time throw out both grain and ſtraw upon the concave rack M, lying horizontally with ſlender parallel ribs, ſo that the corn paſſes through them into a hopper N placed below. From the hopper it paſſes through a harp or riddle O into a pair of fanners P, from which, in the moſt improved machines, it comes out clean and fit for the market. The ſtraw, after being thrown by the ſcutchers *a*, *b*, *c*, *d*, into the rack, is removed from it by a rake QRST into a place contiguous V. The rake conſiſts of four thin pieces of wood or leaves; on the end of each of theſe leaves is ranged a row of teeth *e*, *f*, *g*, *h*, five inches long. The rake moves in a circular manner in the concave rack, while the teeth catch hold of the ſtraw, and throw it out of the rack. Theſe are all the eſſential parts of the machine; the reſt may be eaſily underſtood by the references to the Plate. W is the horſe-courſe, N° 1, which is 27 feet diameter. X is the pillar for ſupporting the beams on which the axle of the ſpur-wheel is fixed. YYY are three ſpindles for moving the two fluted rollers, the rake, and fanners. To the deſcription now given we have only to add, that the drum has a covering of wood Z at a ſmall diſtance above it, for the purpoſe of keeping the ſheaves cloſe to the ſcutchers.

The advantages of this machine are many. As the drum makes 300 revolutions in a minute, the four ſcutchers together make 200 ſtrokes in the ſame ſpace of time. From ſuch power and velocity, it is evident that much work muſt be performed. When the horſes go at the rate of two and one-third miles per hour, from three to ſix bolls will be thraſhed; but as the quantity thraſhed will be leſs when the ſtraw is long than when it is ſhort, we ſhall take the average at four bolls. One gentleman, whoſe veracity and accuracy we can depend on, aſſures us, that his mill thraſhed 63 bolls in a day; by which, we ſuppoſe, he meant 10 hours. To prove the ſuperior advantage of this machine to the common method of thraſhing with flails, a gentleman ordered two equal quantities of oats to be thraſhed by the mill and by flails. When the corn was cleaned and meaſured, he obtained one-ſixteenth more from the ſheaves thraſhed by the mill than from thoſe thraſhed by the flail. We are alſo informed by another gentleman who has ſtudied this machine with much attention, and calculated its advantages with care, that, independently of having the corn much cleaner ſeparated from the ſtraw than is uſually done by flails, there is a ſaving of 30 or 40 per cent. in the expence of thraſhing.

The number of perſons requiſite for attending the mill when working is ſix: One perſon drives the horſes; a ſecond hands the ſheaves to a third, who unties them, while a fourth ſpreads them on the inclined boards and preſſes them gently between the rollers; a fifth perſon is neceſſary to riddle the corn as it falls from the fanners, and a ſixth to remove the ſtraw (A).

This machine can be moved equally well by water, wind, or horſes. Mr Meikle has made ſuch improvements on the wind-mill as to render it much more manageable and convenient than formerly; and we are informed many wind-mills are now erecting in different parts of the country. As to the comparative expence of theſe different machines, the erection of the horſe machine is leaſt; but then the expence of employing horſes muſt be taken into conſideration. One of this kind may be erected for 70l. A water mill will coſt 10l. more on account of the expence of the water-wheel. A wind-mill will coſt from 200l. to 300l. ſterling.

THRAVE *of* CORN, an expreſſion denoting 24 ſheaves or four ſhocks of ſix ſheaves to the ſhock; though in ſome countries they only reckon 12 ſheaves to the thrave.

THRASYBULUS, a renowned Athenian general and patriot, the deliverer of his country from the yoke of the 30 tyrants, lived about 294 B. C *.

* See *Attica*, N° 99—174.

THRASYMENUS LACUS, in *Ancient Geography*, a lake of Etruria, near Peruſia, and not far from the Tiber, fatal to the Romans in the Punic war. Now *Il Lago de Perugia* in the Eccleſiaſtical State.

THREAD, a ſmall line made up of a number of fine fibres of any vegetable or animal ſubſtance, ſuch as flax, cotton, or ſilk; from which it takes its name of linen, cotton, or ſilk thread.

THREATENING LETTERS. Knowingly to ſend any letter without a name, or with a fictitious name, demanding money, or any other valuable thing, or threatening (without any demand) to kill or fire the houſe of any perſon, is made felony without benefit of clergy. And ſending letters, threatening to accuſe any perſon of a crime puniſhable with death, tranſportation, pillory, or other infamous puniſhment, with a view to extort from him any money or other valuable chattels, is puniſhable by ſtatute 30 Geo. II. cap. 24. at the diſcretion of the court, with fine, impriſonment, pillory, whipping, or tranſportation for ſeven years.

THRESHING. See THRASHING.

THRIFT. See STATICE, BOTANY *Index*.

THRINAX, SMALL JAMAICA FAN-PALM, a genus of plants belonging to the claſs of palmæ. See BOTANY *Index*.

THRIPS, a genus of inſects belonging to the order of hemiptera. See BOTANY *Index*.

THROAT, the anterior part of an animal, between the head and the ſhoulders.

THROAT-WORT. See CAMPANULA, BOTANY *Index*.

THRONE, a royal ſeat or chair of ſtate, enriched with ornaments of architecture and ſculpture, raiſed on one or more ſteps, and covered with a kind of canopy. Such are the thrones in the rooms of audience of kings and other ſovereigns.

(A) We add, on the authority of an experienced farmer, that of the ſix perſons neceſſary to attend the thraſhing machine, only two can in juſtice be charged to the account of the machine; namely, the perſon who manages the horſes, and the one who feeds the machine: For in the uſual mode of thraſhing by the flail, it requires the ſame number of perſons as the thraſhing machine does to clear an equal quantity of corn from the chaff in the ſame time.

THROSTLE. See Turdus, } Ornithology *Index.*
THRUSH. See Turdus, }

Thrush, or *Aphtha.* See Medicine *Index.*

THRYALLIS, a genus of plants belonging to the claſs decandria, and order of monogynia; and in the natural ſyſtem ranging under the 38th order, *Tricoccæ.* See Botany *Index.*

THUANUS, Jacobus Augustus, youngeſt ſon of the preſident de Thou, was famous for his erudition. He was born in 1553; and having finiſhed his ſtudies and travels, was made preſident a-mortier, and took poſſeſſion thereof in 1595. He was employed in ſeveral important offices of ſtate, and in reforming the univerſity of Paris. He wrote the hiſtory of his own time in Latin, from the year 1543 to 1608, in 138 books; a work, both for ſubject and ſtyle, worthy of the ancients. He alſo left memoirs of his own life, beſides poems; and died at Paris, 1617.

THUCYDIDES, a celebrated Greek hiſtorian, was born at Athens 471 B. C. He was the ſon of Olorus, and grandſon of Miltiades, who is thought to have been deſcended from Miltiades the famous Athenian general, and to have married the king of Thrace's daughter. He was educated in a manner ſuitable to his quality, that is, in the ſtudy of philoſophy and eloquence. His maſter in the former was Anaxagoras, in the latter Antiphon; one, by his deſcription in the eighth book of his Hiſtory, for power of ſpeech almoſt a miracle, and feared by the people on that account. Suidas and Photius relate, that when Herodotus recited his hiſtory in public, a faſhion in uſe then and many ages after, Thucydides felt ſo great a ſting of emulation, that it drew tears from him; inſomuch that Herodotus himſelf took notice of it, and congratulated his father on having a ſon who ſhowed ſo wonderful an affection to the Muſes. Herodotus was then 29 years of age, Thucydides about 16.

When the Peloponneſian war began to break out, Thucydides conjectured truly, that it would prove a ſubject worthy of his labour; and it no ſooner commenced than he began to keep a journal. This explains the reaſon why he has attended more to chronological order than to unity of deſign. During the ſame war he was commiſſioned by his countrymen to relieve Amphipolis; but the quick march of Braſidas the Lacedæmonian general defeated his operations; and Thucydides, unſucceſsful in his expedition, was baniſhed from Athens. This happened in the eighth year of this celebrated war; and in the place of his baniſhment the general began to write an impartial hiſtory of the important events which had happened during his adminiſtration, and which ſtill continued to agitate the ſeveral ſtates of Greece. This famous hiſtory is continued only to the 21ſt year of the war, and the remaining part of the time till the demolition of the walls of Athens was deſcribed by the pen of Theopompus and Xenophon. Thucydides wrote in the Attic dialect, as being poſſeſſed of moſt vigour, purity, elegance, and energy. He ſpared neither time nor money to procure authentic materials; and the Athenians, as well as their enemies, furniſhed him with many valuable communications, which contributed to throw great light on the different tranſactions of the war. His hiſtory has been divided into eight books; the laſt of which is imperfect, and ſuppoſed to have been written by his daughter.

Lempriere's Dictionary.

The hiſtorian of Halicarnaſſus has often been compared with the ſon of Olorus, but each has his peculiar excellence. Sweetneſs of ſtyle, grace and elegance of expreſſion, may be called the characteriſtics of the former; while Thucydides ſtands unequalled for the fire of his deſcriptions, the conciſeneſs, and at the ſame time the ſtrong and energetic manner of his narratives. His relations are authentic, as he himſelf was intereſted in the events he mentions; his impartiality is indubitable, as he nowhere betrays the leaſt reſentment againſt his countrymen, and the factious partizans of Cleon, who had baniſhed him from Athens. The hiſtory of Thucydides was ſo admired by Demoſthenes, that he tranſcribed it eight different times, and read it with ſuch attention, that he could almoſt repeat it by heart. Thucydides died at Athens, where he had been recalled from his exile about 411 years B. C.

The beſt edition of Thucydides is that of Oxford, publiſhed in 1696, folio, and that of Duker, publiſhed at Amſterdam in 1731, folio.

THUJA, the Arbor Vitæ; a genus of plants belonging to the claſs of monadelphia, and order of monœcia; and in the natural ſyſtem ranging under the 51ſt order, *Coniferæ.* See Botany *Index.*

THULE, or Thylæ, in *Ancient Geography*, an iſland in the moſt northern parts of the German ocean. Its ſituation was never accurately aſcertained by the ancients, hence its preſent name is unknown by modern hiſtorians. Some ſuppoſe that it is the iſland now called Iceland, or part of Greenland, and others that it was *Foula.* See Foula.

THUMB, in *Anatomy*, one of the extremities of the hand.

THUMB-Cap, an uninhabited iſland in the South ſea, lies about ſeven leagues north-weſt of Lagoon iſland; it is low, woody, of a circular form, and not much above a mile in compaſs.

THUMMIM. See Urim.

THUNBERGIA, a genus of plants belonging to the claſs of didynamia. See Botany *Index.*

THUNDER, the noiſe occaſioned by the exploſion of a flaſh of lightning echoed back from the inequalities on the ſurface of the earth, in like manner as the noiſe of a cannon is echoed, and in particular circumſtances forms a rolling lengthened ſound. See Electricity.

THUNDERBOLT. When lightning acts with extraordinary violence, and breaks or ſhatters any thing, it is called a *thunderbolt;* which the vulgar, to fit it for ſuch effects, ſuppoſe to be a hard body, and even a ſtone. But that we need not have recourſe to a hard ſolid body to account for the effects commonly attributed to the thunderbolt, will be evident to any one who conſiders thoſe of the pulvis fulminans and of gunpowder; and more eſpecially the aſtoniſhing powers of electricity. It has been ſuppoſed that meteoric ſtones may have given riſe to the notion of a thunderbolt.

THUNDER-Houſe. See Electricity.

THURINGIA, a diviſion of the circle of Upper Saxony in Germany. It is a fruitful tract, abounding in corn, eſpecially wheat; in black cattle, ſheep, and horſes. It is about 73 miles in length, and as much in breadth. It contains 47 towns, 14 boroughs, betwixt 700 and 800 villages, 300 noble eſtates, 7 ſuperintendencies, and 5 under-conſiſtories. Thuringia, the country of the ancient Thuringi, or Catti, a branch of the

Thuringia
||
Tibet.

Vandals, mentioned by Tacitus, was formerly a kingdom, afterwards a county, then a landgravate, and was governed by its own princes for many ages, till 1124, when it devolved to the marquis of Miſnia, and, with that country, afterwards to the duke of Saxony. But the modern Thuringia is only a part of the ancient, nay, but a part of the ancient South Thuringia, which comprehends beſides, a large ſhare of the modern Franconia, Heſſe, &c. On the extinction of the male line of the ancient landgraves in 1247, it came to the margraves of Meiſſen, anceſtors to the preſent electoral family. The elector has no voice in the diet, on account of his ſhare in the landgravate or circle of Thuringia. Erfurt is the capital.

THURSDAY, the fifth day of the Chriſtian week, but the ſixth of that of the Jews.

THUS, Frankincense, a ſolid brittle reſin, brought to us in little globes or maſſes, of a browniſh or yellowiſh colour on the outſide, internally whitiſh or variegated with whitiſh ſpecks. It is ſuppoſed to be the produce of the pine that yields the common turpentine, and to concrete upon the ſurface of the terebinthinate juice ſoon after it has iſſued from the tree. See Incense.

THUYA. See Thuja.

THYMUS, Thyme; a genus of plants belonging to the claſs of didynamia, and in the natural ſyſtem ranging under the 42d order, *Verticillatæ*. See Botany *Index*.

Thymus. See Anatomy *Index*.

THYRSUS, in antiquity, the ſceptre which the poets put into the hand of Bacchus, and wherewith they furniſhed the menades in their Bacchanalia.

Thyrsus, a mode of flowering reſembling the cone of a pine. It is, ſays Linnæus, a panicle contracted into an oval or egg-ſhaped form. The lower footſtalks, which are longer, extend horizontally, whilſt the upper ones are ſhorter and mount vertically. Lilac and butter-bur furniſh examples.

TIARA, an ornament or habit wherewith the ancient Perſians covered their head; and with which the Armenians and kings of Pontus are repreſented on medals; theſe laſt, becauſe they were deſcended from the Perſians. Latin authors call it indifferently *tiara* and *cidaris*. Strabo ſays, the tiara was in form of a tower; and the ſcholiaſt on Ariſtophanes's comedy, Αχαρνης, act i. ſcene 2. affirms, that it was adorned with peacocks feathers.

Tiara is alſo the name of the pope's triple crown. The tiara and keys are the badges of the papal dignity; the tiara of his civil rank, and the keys of his juriſdiction: for as ſoon as the pope is dead, his arms are repreſented with the tiara alone, without the keys. The ancient tiara was a round high cap. John XXIII. firſt encompaſſed it with a crown. Boniface VIII. added a ſecond crown; and Benedict XII. a third.

TIARELLA, a genus of plants belonging to the claſs of decandria; and in the natural ſyſtem ranging under the 13th order, *Succulentæ*. See Botany *Index*.

TIBER, a great river of Italy, which runs through the pope's territories, paſſing by Perugia and Orvietto; and having viſited Rome, falls into the Tuſcan ſea at Oſtia, 15 miles below that city.

Tibet.

TIBET, called by the Tartars *Barantola*, *Bootan*, or *Tangoot*, and by the Chineſe *Tſang*, is ſituated between 27° and 35° north latitude; and is reckoned to be 1350 miles from eaſt to weſt, and 480 from north to ſouth. It is bounded on the north by the country of the Mongols and the deſert of Kobi; on the eaſt by China; on the weſt by Hindoſtan, and on the ſouth by the ſame country and the kingdom of Ava. In the valleys lying between the lower mountains are many tribes of Indian people; and a diſpute happening between the heirs of one of the rajahs or petty princes, one party called to their aſſiſtance the Boutaners, and the other the Britiſh. The latter prevailed; and the fame of Britiſh valour being carried to the court of Tibet, the Teeſhoo Lama, who ruled the ſtate under the Delai-Lama, at that time in his minority, ſent a deputation to Bengal, deſiring peace for the prince who had been engaged in war with the Britiſh. This was readily granted by the governor; and Mr Bogle was ſent ambaſſador to the court of Tibet, where he reſided ſeveral months; and after an abſence of a year and a quarter, returned to Calcutta. The account of this gentleman's expedition hath not been publiſhed by himſelf; but from Mr Stewart's letter to Sir John Pringle, publiſhed in the Philoſophical Tranſactions, vol. lxvii. we learn the following particulars, collected from his papers.

"Mr Bogle divides the territories of the Delai-Lama into two different parts. That which lies immediately contiguous to Bengal, and which is called by the inhabitants *Doopo*, he diſtinguiſhes by the name of *Bootan;* and the other, which extends to the northward as far as the frontiers of Tartary, called by the natives *Pu*, he ſtyles *Tibet*. Bootan is ruled by the Dah Terriah, or Deb Rajah. It is a country of ſteep and inacceſſible mountains, whoſe ſummits are crowned with eternal ſnow; they are interſected with deep valleys, through which pour numberleſs torrents that increaſe in their courſe, and at laſt, gaining the plains, loſe themſelves in the great rivers of Bengal. Theſe mountains are covered down their ſides with foreſts of ſtately trees of various ſorts; ſome (ſuch as pines, &c.) which are known in Europe; others, ſuch as are peculiar to the country and climate. The valleys and ſides of the hills which admit of cultivation are not unfruitful, but produce crops of wheat, barley, and rice. The inhabitants are a ſtout and warlike people, of a copper complexion, in ſize rather above the middle European ſtature, haſty and quarrelſome in their temper, and addicted to the uſe of ſpirituous liquors; but honeſt in their dealings, robbery by violence being almoſt unknown among them. The chief city is Taſſey Seddein, ſituated on the Patchoo. Tibet begins properly from the top of the great ridge of the Caucaſus, and extends from thence in breadth to the confines of Great Tartary, and perhaps to ſome of the dominions of the Ruſſian empire. The woods, which everywhere cover the mountains in Boutan, are here totally unknown; and, except a few ſtraggling trees near the villages, nothing of the ſort is to be ſeen. The climate is extremely ſevere and rude. At Chamnanning, where he wintered, although it be in latitude 31° 39′, only 8° to the northward of Calcutta, he often found the thermometer in his room at 29° by Fahrenheit's ſcale; and in the middle of April the ſtanding waters were all frozen, and heavy ſhowers of ſnow perpetually fell. This, no doubt, muſt be owing to the great elevation of the country, and to the vaſt frozen ſpace over which the north wind blows uninterrupted from the pole, through the vaſt deſerts of Siberia and Tartary, till it is ſtopped by this formidable wall.

“ The Tibetians are of a ſmaller ſize than their ſouthern neighbours, and of a leſs robuſt make. Their complexions are alſo fairer, and many of them have even a ruddineſs in their countenances unknown to the other climates of the eaſt. Thoſe whom Mr Bogle ſaw at Calcutta appeared to have quite the Tartar face. They are of a mild and cheerful temper; the higher ranks are polite and entertaining in converſation, in which they never mix either ſtrained compliments or flattery. The common people, both in Bootan and Tibet, are clothed in coarſe woollen ſtuffs of their own manufacture, lined with ſuch ſkins as they can procure: but the better orders of men are dreſſed in European cloth, or China ſilk, lined with the fineſt Siberian furs. The uſe of linen is totally unknown among them. The chief food of the inhabitants is the milk of their cattle, prepared into cheeſe, butter, or mixed with the flour of a coarſe barley or of peaſe, the only grain which their ſoil produces; and even theſe articles are in a ſcanty proportion: but they are furniſhed with rice and wheat from Bengal and other countries in their neighbourhood. They alſo are ſupplied with fiſh from the rivers in their own and the neighbouring provinces, ſalted and ſent into the interior parts. They have no want of animal food from the cattle, ſheep, and hogs, which are raiſed on their hills; and are not deſtitute of game. They have a ſingular method of preparing their mutton, by expoſing the carcaſe entire, after the bowels are taken out, to the ſun and bleak northern winds which blow in the months of Auguſt and September, without froſt, and ſo dry up the juices and parch the ſkin, that the meat will keep uncorrupted for the year round. This they generally eat raw, without any other preparation.

“ The religion and political conſtitution of this country, which are intimately blended together, would make a conſiderable chapter in its hiſtory. It ſuffices to ſay, that at preſent, and ever ſince the expulſion of the Eluth Tartars, the kingdom of Tibet is regarded as depending on the empire of China, which they call *Cathay*; and there actually reſide two mandarins, with a garriſon of a thouſand Chineſe, at Lahaſſa the capital, to ſupport the government; but their power does not extend far: and in fact the Lama, whoſe empire is founded on the ſureſt grounds, perſonal affection and religious reverence, governs every thing internally with unbounded authority. Every body knows that the Delai Lama is the great object of adoration for the various tribes of heathen Tartars, who roam through the vaſt tract of continent which ſtretches from the banks of the Volga to Correa on the ſea of Japan, the moſt extenſive religious dominion, perhaps, on the face of the globe. See LAMA.

“ It is an old notion, that the religion of Tibet is a corrupted Chriſtianity: and even Father Diſederii, a Jeſuit (but not of the Chineſe miſſion) who viſited the country about the beginning of this century, thinks he can reſolve all their myſteries into ours; and aſſerts, with a truly myſtical penetration, that they have certainly a good notion of the Trinity, ſince in their addreſs to the Deity, they ſay as often *konciok-oik* in the plural as *konciok* in the ſingular, and with their roſaries pronounce theſe words *om*, *ha*, *hum*. The truth is, that the religion of Tibet, from whatever ſource it ſprung, is pure and ſimple in its ſource, conveying very exalted notions of the Deity, with no contemptible ſyſtem of morality: but in its progreſs it has been greatly altered and corrupted by the inventions of worldly men; a fate we can hardly regret in a ſyſtem of error, ſince we know that that of truth has been ſubject to the ſame. Polygamy, at leaſt in the ſenſe we commonly receive the word, is not in practice among them; but it exiſts in a manner ſtill more repugnant to European ideas; for there is a plurality of huſbands, which is firmly eſtabliſhed and highly reſpected there. In a country where the means of ſubſiſting a family are not eaſily found, it ſeems not impolitic to allow a ſet of brothers to agree in raiſing one, which is to be maintained by their joint efforts. In ſhort, it is uſual in Tibet for the brothers in the family to have a wife in common, and they generally live in great harmony and comfort with her; not but ſometimes little diſſenſions will ariſe (as may happen in families conſtituted upon different principles), an inſtance of which Mr Bogle mentions in the caſe of a modeſt and virtuous lady, the wife of half a dozen of the Teeſhoo Lama's nephews, who complained to the uncle that the two youngeſt of her huſbands did not furniſh that ſhare of love and benevolence to the common ſtock which duty and religion required of them. In ſhort, however ſtrange this cuſtom may appear to us, it is an undoubted fact that it prevails in Tibet.

“ The dead are expoſed on the pinnacle of ſome neighbouring mountain, to be devoured by wild beaſts and birds of prey, or waſted away by time and the viciſſitudes of the weather in which they lie. The mangled carcaſes and bleached bones lie ſcattered about; and amidſt this ſcene of horror, ſome miſerable old wretch, man or woman, loſt to all feelings but thoſe of ſuperſtition, generally ſets up an abode, to perform the diſmal office of receiving the bodies, aſſigning each a place, and gathering up the remains when too widely diſperſed.”

To the account of Tibet which we have given from the communications of Mr Bogle, we may add the information which we have obtained from a later traveller, Mr Saunders * ſurgeon at Boglepoer in Bengal, who made a journey into Tibet in the year 1783. His obſervations chiefly reſpect the natural productions and diſeaſes of the country.

The plants which Mr Saunders found were almoſt all European plants, a great number of them being natives of Britain. From the appearance of the hills he concludes that they muſt contain many ores of metal and pyrites. There are inexhauſtible quantities of tincal or borax, and rock-ſalt is plentiful; gold-duſt is found in great quantities in the beds of rivers, and ſometimes in large maſſes, lumps, and irregular veins; lead, cinnabar containing a large proportion of quickſilver, copper, and iron, he thinks, might eaſily be procured. But the inhabitants of Tibet have no better fuel than the dung of animals. A coal mine would be a valuable diſcovery. We are told, that in ſome parts of China bordering on Tibet coal is found and uſed as fuel.

It is remarkable that the ſame diſeaſe prevails at the

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* *Paper in the Phil. Tranſ.* vol. lxxix.

foot of the mountains of Tibet as in Switzerland at the foot of the Alps, a glandular ſwelling in the throat commonly called *goitre*.

The language ſpoken in Tibet is different from that of the Tartars. The aſtronomers are acquainted with the motion of the heavenly bodies, and able to calculate eclipſes; but the lamas are generally ignorant; few of them can read, much leſs underſtand their ancient books.

TIBULLUS, AULUS ALBIUS, a Roman knight, and a celebrated Latin poet, was born at Rome 43 B. C. He was the friend of Horace, Ovid, Macer, and other great men in the reign of Auguſtus. He accompanied Meſſala Corvinus in his expedition againſt the iſland of Corcyra: but falling ſick, and being unable to ſupport the fatigues of war on account of the weakneſs of his conſtitution, he quitted the profeſſion of arms, and returned to Rome, where he died before the year 17; when Ovid ſhowed his grief for his death by writing a fine elegy upon him. Tibullus wrote four books of elegies, which are ſtill extant: they are written in a tender and agreeable ſtyle, and in very elegant Latin. Muret and Joſeph Scaliger have written learned and curious commentaries on the works of this poet. The beſt edition of Tibullus is that of Janus Bronckhuſius, publiſhed at Amſterdam in 1708, in one volume quarto. We have an Engliſh poetical verſion by Mr Grainger.

TIBUR, in *Ancient Geography*, a town of Latium, pleaſantly ſituated on the Anio. Here Horace had his villa and houſe; and here he wiſhed to end his days. Here Adrian built an extraordinary villa called *Tiburtina*, inſcribed with the names of the provinces and of the moſt conſiderable places, (Spartian); near which Zenobia had a houſe called *Zenobia*, (Trebellius, Pollio). Hither Auguſtus often retreated on account of its ſalubrity, (Suetonius): for which it is greatly recommended, (Martial). Anciently, when the Romans had far extended their territory, it was the utmoſt place of baniſhment, (Ovid). It had a temple of Hercules; and therefore called *Herculeum*. In the temple was a library, (A. Gellius). Now *Tivoli* in the Campagna di Roma, on the Teverone.

TICINUS, in *Ancient Geography*, a river in Inſubria, riſing in Mount Adula, traverſing the Lacus Verbanus ſouthwards, and falling into the Po near Ticinum. Between this river and the Po Hannibal gained his firſt victory over the Romans under P. Scipio. The general himſelf eſcaped with the utmoſt difficulty, and that by the bravery of his ſon the firſt Scipio Africanus. Now the *Teſino*, riſing in Mount Godard, running ſouth through the Lago Maggiore and Milan, by Pavia, into the Po.

TICK. See ACARUS, ENTOMOLOGY *Index*.

TICKELL, THOMAS, an excellent Engliſh poet, was the ſon of the Reverend Richard Tickell, and was born in 1686. at Bridekirk in Cumberland. He was educated at Queen's college, Oxford, of which he was made fellow; and while he continued at that univerſity, he addreſſed to Mr Addiſon a complimentary copy of verſes on his Opera of Roſamond, which introduced him to an acquaintance with that gentleman, who diſcovering his merit, became his ſincere friend. On Mr Addiſon being made ſecretary of ſtate, he appointed Mr Tickell his under-ſecretary; and on his being obliged to reſign that office on account of his ill health, he recommended him ſo effectually to Mr Craggs his ſucceſſor, that he was continued in his poſt till that gentleman's death. In 1724, Mr Tickell was appointed ſecretary to the lords juſtices in Ireland, and enjoyed that place as long as he lived. He wrote ſome poems, which, when ſeparately publiſhed, met with a favourable reception, and paſſed through ſeveral editions: they are now printed in the ſecond volume of the Minor Poets. After Mr Addiſon's death Mr Tickell had the care of the edition of his works printed in 4 vols. 4to; to which he prefixed an account of Mr Addiſon's life, and a poem on his death. Mr Tickell died in the year 1740.

TICKERA, a conſiderable article of merchandiſe in Fezzan in Africa; it is valued by travellers as a portable and highly ſalubrious food. It is a preparation of pounded dates, and the meal of Indian corn, formed into a paſte, and highly dried in an oven.

TICKSEED, SUN-FLOWER. See COREOPSIS, BOTANY *Index*.

TICUNAS. See POISON.

TIDE, is a word which expreſſes that riſing and falling of the waters which are obſerved on all maritime coaſts.

There is a certain depth of the waters of the ocean which would obtain if all were at reſt: but obſervation ſhows that they are continually varying from this level, and that ſome of theſe variations are regular and periodical.

1ſt, It is obſerved, that on the ſhores of the ocean, and in bays, creeks, and harbours, which communicate freely with the ocean, the waters riſe up above this mean height twice a-day, and as often ſink below it, forming what is called a FLOOD and an EBB, a HIGH and LOW WATER. The whole interval between high and low water is called a TIDE; the water is ſaid to FLOW and to EBB; and the riſing is called the FLOOD-TIDE, and the falling is called the EBB TIDE.

2d, It is obſerved, that this riſe and fall of the waters is variable in quantity. At Plymouth, for inſtance, it is ſometimes 21 feet between the greateſt and leaſt depth of the water in one day, and ſometimes only 12 feet.

Theſe different heights of tide are obſerved to ſucceed each other in a regular ſeries, diminiſhing from the greateſt to the leaſt, and then increaſing from the leaſt to the greateſt. The greateſt is called a SPRING TIDE, and the leaſt is called a NEAP TIDE.

3d, This ſeries is completed in about 15 days. More careful obſervation ſhows that two ſeries are completed in the exact time of a lunation. For the ſpring tide in any place is obſerved to happen preciſely at a certain interval of time (generally between two and three days) after new or full moon; and the neap tide at a certain interval after half moon: or, more accurately ſpeaking, it is obſerved that the ſpring tide always happens when the moon has got a certain number of degrees eaſtward of the line of conjunction and oppoſition, and the neap tide happens when ſhe is a certain number of degrees from her firſt or laſt quadrature. Thus the whole ſeries of tides appears to be regulated by the moon.

4th, It is obſerved that high water happens at new and full moon, when the moon has a certain determined poſition with reſpect to the meridian of the place of obſervation, preceding or following the moon's ſouthing a certain interval of time; which is conſtant with reſpect to that place, but very different in different places.

5th, The time of high water in any place appears to be regulated by the moon; for the interval between the time of high water and the moon's ſouthing never changes above three quarters of an hour, whereas the interval between the time of high water and noon changes ſix hours in the courſe of a fortnight.

6th, The interval between two ſucceeding high waters is variable. It is leaſt of all about new and full moon, and greateſt when the moon is in her quadratures. As two high waters happen every day, we may call the double of their interval a TIDE DAY, as we call the diurnal revolution of the moon a *lunar day*. The tide is ſhorteſt about new and full moon, being then about 24^h 37′; about the time of the moon's quadratures it is 25^h 27′. Theſe values are taken from a mean of many obſervations made at Barbadoes by Dr Maſkelyne.

7th, The tides in ſimilar circumſtances are greateſt when the moon is at her ſmalleſt diſtance from the earth, or in her perigee, and, gradually diminiſhing, are ſmalleſt when ſhe is in her apogee.

8th, The ſame remark is made with reſpect to the ſun's diſtance, and the greateſt tides are obſerved during the winter months of Europe.

9th, The tides in any part of the ocean increaſe as the moon, by changing her declination, approaches the zenith of that place.

10*th*, The tides which happen while the moon is above the horizon are greater than the tides of the ſame day when the moon is below the horizon.

Such are the regular phenomena of the tides. They are important to all commercial nations, and have therefore been much attended to. It is of the tides, in all probability, that the Bible ſpeaks, when God is ſaid to ſet bounds to the ſea, and to ſay, "thus far ſhall it go, and no farther."

Homer is the earlieſt profane author who ſpeaks of the tides. Indeed it is not very clear that it is of them that he ſpeaks (in the 12th book of the Odyſſey) when he ſpeaks of Charybdis, which riſes and retires thrice in every day. Herodotus and Diodorus Siculus ſpeak more diſtinctly of the tides in the Red ſea. Pytheas of Marſeilles is the firſt who ſays any thing of their cauſe. According to Strabo he had been in Britain, where he muſt have obſerved the tides of the ocean. Plutarch ſays expreſsly that Pytheas aſcribed them to the moon. It is ſomewhat wonderful that Ariſtotle ſays ſo little about the tides. The army of Alexander, his pupil, were ſtartled at their firſt appearance to them near the Perſian gulf; and we ſhould have thought that Ariſtotle would be well informed of all that had been obſerved there. But there are only three paſſages concerning them in all Ariſtotle's writings, and they are very trivial. In one place he ſpeaks of great tides obſerved in the north of Europe; in another, he mentions their having been aſcribed by ſome to the moon; and in a third, he ſays, that the tide in a great ſea exceeds that in a ſmall one.

The Greeks had little opportunity of obſerving the tides. The conqueſts and the commerce of the Romans gave them more acquaintance with them. Cæſar ſpeaks of them in the 4th book of his Gallic War. Strabo, after Poſidonius, claſſes the phenomena into daily, monthly, and annual. He obſerves, that the ſea riſes as the moon gets near the meridian, whether above or below the horizon, and falls again as ſhe riſes or falls; alſo, that the tides increaſe at the time of new and full moon, and are greateſt at the ſummer ſolſtice. Pliny explains the phenomena at ſome length; and ſays, that both the ſun and moon are their cauſe, dragging the waters along with them (B. II. c. 97). Seneca (*Nat. Queſt.* III. 28.) ſpeaks of the tide with correctneſs; and Macrobius (*Somn. Scip.* I. 6.) gives a very accurate deſcription of their motions.

It is impoſſible that ſuch phenomena ſhould not exerciſe human curioſity as to their cauſe. Plutarch (*Plaut. Phil.* III. 17.), Galileo (*Syſt. Mund.* Dial. 4.), Riccioli in his *Almageſt*, ii. p. 374, and Gaſſendi, ii. p. 27. have collected moſt of the notions of their predeceſſors on the ſubject; but they are of ſo little importance, that they do not deſerve our notice. Kepler ſpeaks more like a philoſopher (*De Stella Martis*, and *Epit. Aſtron.* p. 555.). He ſays that all bodies attract each other, and that the waters of the ocean would all go to the moon were they not retained by the attraction of the earth; and then goes on to explain their elevation under the moon and on the oppoſite ſide, becauſe the earth is leſs attracted by the moon than the nearer waters, but more than the waters which are more remote.

The honour of a complete explanation of the tides was reſerved for Sir Iſaac Newton. He laid hold of this claſs of phenomena as the moſt inconteſtable proof of univerſal gravitation, and has given a moſt beautiful and ſynoptical view of the whole ſubject; contenting himſelf, however, with merely exhibiting the chief conſequences of the general principle, and applying it to the phenomena with ſingular addreſs. But the wide ſteps taken by this great philoſopher in his inveſtigation leave ordinary readers frequently at fault: many of his aſſumptions require the greateſt mathematical knowledge to ſatisfy us of their truth. The academy of Paris therefore propoſed to illuſtrate this among other parts of the principles of natural philoſophy, and publiſhed the theory of the tides as a prize problem. This produced three excellent diſſertations by M'Laurin, Dan. Bernoulli, and Euler. Aided by theſe, and chiefly by the ſecond, we ſhall here give a phyſical theory, and accommodate it to the purpoſes of navigation by giving the rules of calculation. We have demonſtrated in our diſſertations on the phyſical principles of the celeſtial motions, that it is an unexcepted fact, that every particle of matter in the ſolar ſyſtem is actually deflected toward every other particle; and that the deflection of a particle of matter toward any diſtant ſphere is proportional to the quantity of matter in that ſphere directly, and to the ſquare of the diſtance of the particle from the centre of that ſphere inverſely: and having found that the heavineſs of a piece of terreſtrial matter is nothing but the ſuppoſed opponent to the force which we exert in carrying this piece of matter, we conceive it as poſſeſſing a property, that is, diſtinguiſhing quality, manifeſted by its being *gravis* or heavy. This is heavineſs, *gravitas*, gravity; and the manifeſtation of this quality, or the event in which it is ſeen, whether it be directly falling, or deflecting in a parabolic curve, or ſtretching a coiled ſpring, or breaking a rope, or ſimply preſſing on its ſupport, is *gravitatio*, gravitation; and the body is ſaid to gravitate. When all obſtacles are removed from the body, as when we cut the ſtring by which a ſtone is hung, it moves directly downwards, *tendit ad terram. Si diſcindatur funis tenderet lapis ad terram. Dum vero funis integer perſtet, lapis terram verſus niti cenſetur.* By ſome metaphyſical proceſs, which it is needleſs at preſent to trace, this *niſus ad motum* has been called a *tendency* in our language. Indeed the word has now come to ſignify the energy of any active quality in thoſe caſes where its ſimpleſt and moſt immediate manifeſtation is prevented by ſome obſtacle. The ſtone is now ſaid to tend towards the earth, though it does not actually approach it, being withheld by the ſtring. The ſtretching the ſtring in a direction perpendicular to the horizon is conceived as a full manifeſtation of this tendency. This tendency, this energy of its heavineſs, is therefore named by the word which diſtinguiſhes the quality; and it is called *gravitation*, and it is ſaid to *gravitate*.

But Sir Iſaac Newton diſcovered that this deflection of a heavy body differs in no reſpect from that general deflection obſerved in all the bodies of the ſolar ſyſtem. For 16 feet, which is the deflection of a ſtone in one ſecond, has the very ſame proportion to $\frac{1}{19}$th of an inch, which is the ſimultaneous deflection of the moon, that the ſquare of the moon's diſtance from the centre of the earth has to the ſquare of the ſtone's diſtance from it, namely, that of 3600 to 1.

Thus we are enabled to compare all the effects of the mutual tendencies of the heavenly bodies with the tendency of gravity, whoſe effects and meaſures are familiar to us.

If the earth were a ſphere covered to a great depth with water, the water would form a concentric ſpherical ſhell; for the gravitation of every particle of its ſurface would then be directed to the centre, and would be equal. The curvature of its ſurface therefore would be every where the ſame, that is, it would be the uniform curvature of a ſphere.

Plate DXXXVI. Fig. 1.

It has been demonſtrated in former articles, after Sir Iſaac Newton, that the gravitation of a particle C (fig. 1.) to the centre O, is to that of a particle E at the ſurface as CO to EO. In like manner the gravitation of o is to that of p as o to p O. If therefore EO and Op are two communicating canals, of equal lengths, the water in both would be in equilibrio, becauſe each column would exert the ſame total preſſure at O. But if the gravitation of each particle in p O be diminiſhed by a certain proportion, ſuch as $\frac{1}{100}$th of its whole weight, it is plain that the total preſſure of the column p O will be $\frac{1}{100}$th part leſs than that of the column EO. Therefore they will no longer be in equilibrio. The weight of the column EO will prævail; and if a hollow tower Pp be built at the mouth of the pit $p\,o$, the water will ſink in EO and riſe in Op, till both are again in equilibrio, exerting equal total preſſures at O. Or we may prevent the ſinking at E by pouring in more water into the tower Pp. The ſame thing muſt happen in the canal fc perpendicular to EO, if the gravitation of every particle be diminiſhed by a force acting in the direction CF, and proportional to the diſtance of the particle from C, and ſuch, that when c C is equal to o O, the force acting on c is equal to the force acting on o. In order that the former equilibrium may be reſtored after this diminution of the gravitation of the column fC, it is plain that more water muſt be poured into the oblique tower fF. All this is evident when we conſider the matter hydroſtatically. The gravitation of the particle c may be repreſented by o O; but the diminution of the preſſure occaſioned by this at O is repreſented by Cc.

Hence we can collect this much, that the whole diminution of preſſure at C is to the whole diminution of preſſure at O as the ſum of all the lines c C to the ſum of all the lines o O, that is, as $f\mathrm{C}^2$ to PO^2. But the weight of the ſmall quantity of water added in each tower is diminiſhed in the ſame proportion; therefore the quantity added at Ff muſt be to the quantity added at Pp as fC to p O. Therefore we muſt have Ff : Pp = fC : p O, and the points E, F, P, muſt be in the circumference of an ellipſe, of which PO and EO are the tranſverſe and conjugate ſemi-axes.

What we have here ſuppoſed concerning the diminution of gravity in theſe canals is a thing which really obtains in nature. It was demonſtrated, when treating of the *PRECESSION of the Equinoxes*, that if the ſun or moon lie in the direction OP, at a very great diſtance, there reſults from the unequal gravitation of the different particles of the earth a diminution of the gravity of each particle; which diminution is in a direction parallel to OP, and proportional to the diſtance of the particle from a plane paſſing through the centre of the earth at right angles to the line OP.

Thus it happens that the waters of the ocean have their equilibrium diſturbed by the unequal gravitation of their different particles to the ſun or to the moon; and this equilibrium cannot be reſtored till the waters come in from all hands, and riſe up around the line joining the centres of the earth and of the luminary. The ſpherical ocean muſt acquire the form of a prolate ſpheroid generated by the revolution of an ellipſe round its tranſverſe axis. The waters will be higheſt in that place which has the luminary in its zenith, and in the antipodes to that place; and they will be moſt depreſſed in all thoſe places which have the luminary in their horizon. P and P′ will be the poles, and EOQ will be the equator of this prolate ſpheroid.

Mr Ferguſon, in his Aſtronomy, aſſigns another cauſe of this arrangement, viz. the difference of the centrifugal forces of the different particles of water, while the earth is turning round the common centre of gravity of the earth and moon. This, however, is a miſtake. It would be juſt if the earth and moon were attached to the ends of a rod, and the earth kept always the ſame face toward the moon.

It is evident that the accumulation at P and P′, and the depreſſion at the equator, muſt augment and diminiſh in the ſame proportion with the diſturbing force. It is alſo evident that its abſolute quantity may be diſcovered by our knowledge of the proportion of the diſturbing force to the force of gravity.—Now this proportion is known; for the proportion of the gravitation of the earth's centre to the ſun or moon, to the force of gravity at the earth's ſurface, is known; and the proportion of the gravitation of the earth's centre to the luminary, to the difference of the gravitations of the centre and of the ſurface, is alſo known, being very nearly the proportion of the diſtance of the luminary to twice the radius of the earth.

Although this reaſoning, by which we have aſcertained the elliptical form of the watery ſpheroid, be ſufficiently

ciently convincing, it is very imperfect, being accommodated to one condition only of equilibrium, viz. the equilibrium of the canals *fc* and *co*. There are ſeveral other conditions equally neceſſary to which this lax reaſoning will not apply, ſuch as the direction of the whole remaining gravitation in any point F. This muſt be perpendicular to the ſurface, &c. &c. Nor will this mode of inveſtigation aſcertain the eccentricity of the ſpheroid without a moſt intricate proceſs. We muſt therefore take the ſubject more generally, and ſhow the proportion and directions of gravity in every point of the ſpheroid. We need not, however, again demonſtrate that the gravitation of a particle placed any where without a perfect ſpherical ſhell, or a ſphere conſiſting of concentric ſpherical ſhells, either of uniform denſity, or of denſities varying according to ſome function of the radius, is the ſame as if the whole matter of the ſhell or ſphere were collected in the centre. This has been demonſtrated in the article ASTRONOMY. We need only remind the reader of ſome conſequences of this theorem which are of continual uſe in the preſent inveſtigation.

1. The gravitation to a ſphere is proportional to its quantity of matter directly, and to the ſquare of the diſtance of its centre from the gravitating particle inverſely.

2. If the ſpheres be homogeneous and of the ſame denſity, the gravitations of particles placed on their ſurfaces, or at diſtances which are proportional to their diameters, are as the radii; for the quantities of matter are as the cubes of the radii, and the attractions are inverſely as the ſquares of the radii; and therefore the whole gravitations are as $\frac{r^3}{r^2}$, or as r.

3. A particle placed within a ſphere has no tendency to the matter of the ſhell which lies without it, becauſe its tendency to any part is balanced by an oppoſite tendency to the oppoſite part. Therefore,

4. A particle placed any where *within* a homogeneous ſphere gravitates to its centre with a force proportional to its diſtance from it.

It is a much more difficult problem to determine the gravitation of particles to a ſpheroid. To do this in general terms, and for every ſituation of the particle, would require a train of propoſitions which our limits will by no means admit; we muſt content ourſelves with as much as is neceſſary for merely aſcertaining the ratio of the axes. This will be obtained by knowing the ratio of the gravitation at the pole to that at the equator. Therefore.

Fig. 2. Let N *m* S *q* N (fig. 2.) be a ſection through the axis of an oblate homogeneous ſpheroid, which differs very little from a ſphere. NS is the axis, *mq* is the equatorial diameter, O is the centre, and NMSQ is the ſection of the inſcribed ſphere. Let P be a particle ſituated at any diſtance without the ſphere in its axis produced; it is required to determine the gravitation of this particle to the whole matter of the ſpheroid?

Draw two lines PAC, PBD, very near to each other, cutting off two ſmall arches AB, CD; draw GA *a*, HB *b*, IC *c*, KD *d*, perpendicular to the axis; alſo draw OE and AL perpendicular to PAC, and OF perpendicular to PD, cutting PC in *f*. Join OA.

Let OA, the radius of the inſcribed ſphere be r, and OP the diſtance of the gravitating particle be d, and M *m*, the elevation of the equator of the ſpheroid, or the ellipticity, be e. Alſo make $\text{AE}=x$, and $\text{OE}=y, =\sqrt{r^2-x^2}$. Then $\text{AE}-\text{BF}=\dot{x}$ and $\text{F}f=\dot{y}, =\frac{x\dot{x}}{\sqrt{r^2-x^2}}$.

Suppoſe the whole figure to turn round the axis OP. The little ſpace AB *b a* will generate a ring of the redundant matter; ſo will CD *dc*. This ring may be conſidered as conſiſting of a number of thin rings generated by the revolution of A *a*. The ring generated by A *a* is equal to a parallelogram whoſe baſe is the circumference deſcribed by A and whoſe height is A *a*. Therefore let c be the circumference of a circle whoſe radius is 1. The ring will be $\text{A}a\times c\times\text{AG}$. But becauſe *m a* N is an arch of an ellipſe, we have $\text{M}m:\text{A}a=\text{MO}:\text{AG}=r:\text{AG}$, and $\text{A}a=\text{M}m\times\frac{\text{AG}}{r}, =\frac{e}{r}\text{AG}$. Therefore the ſurface of this ring is $=c\frac{e}{r}\text{AG}^2$

We have ſuppoſed the ſpheroid to be very nearly ſpherical, that is, e exceedingly ſmall in compariſon of r. This being the caſe, all the particles in A *a*, and conſequently all the particles in the ring generated by the revolution of A *a*, will attract the remote particle P with the ſame force that A does very nearly. We may ſay the ſame thing of the whole matter of the ring generated by the revolution of AB *b a*. This attraction is exerted in the direction PA by each individual particle. But every action of a particle A is accompanied by the action of a particle A′ in the direction PA′. Theſe two compoſe an attraction in the direction PO. The whole attraction in the directions ſimilar to PA is $=c\times\frac{e}{r}\frac{\text{AG}^2}{\text{PA}^2}\times\text{GH}$, for GH meaſures the number of parallel plates of which the ſolid ring is compoſed. This being decompoſed in the direction PG is $=c\times\frac{e}{r}\times\frac{\text{AG}^2\cdot\text{PG}}{\text{PA}^3}\times\text{GH}$. But $\frac{\text{AG}^2}{\text{PA}^2}=\frac{\text{OE}^2}{\text{PO}^2}$, and $\frac{\text{PG}}{\text{PA}}=\frac{\text{PE}}{\text{PO}}$. Therefore the attraction of the ring, eſtimated in the direction PO, is $=c\times\frac{e}{r}\times\frac{\text{OE}^2\,.\,\text{PE}}{\text{PO}^3}\times\text{GH}$.

Further, by the nature of the circle, we have $\text{HG}:\text{AB}=\text{AG}:\text{AO}$; alſo $\text{AB}:\text{BL}=\text{AO}:\text{OE}$. But $\text{PA}:\text{AG}=\text{PO}:\text{OE}$, and $\text{OE}=\frac{\text{AG}\times\text{PO}}{\text{PA}}$. Therefore

$$\text{AB}:\text{BL}=\text{AO}:\frac{\text{AG}\,.\,\text{PO}}{\text{PA}}, =\text{AO}\,.\,\text{PA}:\text{PO}\,.\,\text{AG}$$

Alſo $\text{BL}:\text{LA}=\text{EO}:\text{EA}$,
And $\text{LA}:\text{F}f=\text{PA}:\text{P}f$, = ultimately $\text{PA}:\text{PE}$.
Therefore, by equality, $\text{HG}:\text{F}f=\text{AG}\,.\,\text{AO}\,.\,\text{PA}\,.\,\text{EO}\,.\,\text{PA}:\text{AO}\,.\,\text{PO}\,.\,\text{AG}\,.\,\text{EA}\,.\,\text{PE}$.
Or $\text{HG}:\text{F}f=\text{EO}\,.\,\text{PA}^2:\text{PO}\,.\,\text{EA}\,.\,\text{PE}$.
And $\text{HG}=\text{F}f\times\frac{\text{EO}\,.\,\text{PA}^2}{\text{PO}\ \text{PE}\,.\,\text{EA}}$.

Now ſubſtitute this value of HG in the formula expreſſing the attraction of the ring. This changes it to $c\frac{e}{r}\times\frac{\text{OE}^2\,.\,\text{PE}}{\text{PO}^3}\times\frac{\text{OE}\,.\,\text{PA}^2}{\text{PO}\,.\,\text{PE}\,.\,\text{EA}}\times\text{F}f$, or $c\frac{e}{r}\times\frac{\text{OE}^3\,.\,\text{PA}^2}{\text{PO}^4\,.\,\text{EA}}\times\text{F}f$. In like manner, the attraction of the

the ring generated by the revolution of CD$d'c$ is $c\frac{e}{r}\times\frac{\mathrm{OE}^3\,.\,\mathrm{PC}^2}{\mathrm{PO}^4\,.\,\mathrm{EA}}\times\mathrm{F}f$. Therefore the attraction of both is $=c\frac{e}{r}\times\mathrm{F}f\times\frac{\mathrm{OE}^3}{\mathrm{PO}^4\,.\,\mathrm{EA}}\times\overline{\mathrm{PA}^2+\mathrm{PC}^2},=c\frac{e}{r}\times\mathrm{F}f\,\frac{y^3}{d^4\,.\,x}\times\overline{\mathrm{PA}^2+\mathrm{PC}^2}$. But $\mathrm{PA}^2+\mathrm{PC}^2=2\,\mathrm{PE}^2+2\,\mathrm{EA}^2,=2\,\mathrm{PE}^2+2\,x^2$. Therefore the attraction is $2c\frac{e}{r\,d^4}\times\mathrm{F}f\frac{y^3}{x}\times\overline{\mathrm{PE}^2+x^2}$. But $\mathrm{F}f=\dot{y},=\frac{x}{y}\dot{x}$. Therefore $\mathrm{F}f\frac{y^3}{x}=\frac{x}{y}\dot{x}\times\frac{y^3}{x},=y^2\dot{x},=\overline{r^2-x^2}\,\dot{x}$.

Therefore the attraction of the two rings is $2c\frac{e}{r\,d^4}\times\overline{r^2-x^2}\times\overline{\mathrm{PE}^2+x^2}\times\dot{x}$. But $\mathrm{PE}^2=\mathrm{PO}^2-\mathrm{OE}^2,=d^2-(r^2-x^2)=d^2-r^2+x^2$. Therefore the attraction of the two rings is

$$2c\frac{e}{r\,d^4}\times\overline{r^2-x^2}\times\overline{d^2-r^2+2x^2}\,\dot{x},=2c\frac{e}{r\,d^4}\times\overline{r^2d^2\dot{x}-r^4\dot{x}+2r^2x^2\dot{x}-d^2x^2\dot{x}+r^2x^2\dot{x}-2x^4\dot{x}}=2c\frac{e}{r\,d^4}\times\frac{*\qquad\qquad *\qquad\qquad\qquad *}{r^2d^2\dot{x}+3r^2x^2\dot{x}-r^4\dot{x}-d^2x^2\dot{x}-2x^4\dot{x}}.$$

The attraction of the whole ſhell of redundant matter will be had by taking the fluent of this formula, which is

$$2c\frac{e}{r\,d^4}\times\left(r^2d^2x+\frac{3r^2x^3}{3}-r^4x-\frac{d^2x^3}{3}-\frac{2x^5}{5}\right),$$

and then make $x=r$. This gives $2c\frac{e}{r\,d^4}(d^2r^3+r^5-r^5-\frac{1}{3}d^2r^3-\frac{2}{5}r^5)$, which is $=2c\frac{e}{r\,d^4}(\frac{2}{3}d^2r^3-\frac{2}{5}r^5)$, $=\frac{4cer^2}{3d^2}-\frac{4r^4}{5d^4}$. To this add the attraction of the inſcribed ſphere, which is $\frac{2}{3}\frac{cr^3}{d^2}$, and we have the attraction of the whole ſpheroid

$$=\frac{2}{3}\frac{cr^3}{d^2}+\frac{4}{3}\frac{cer^2}{d^2}-\frac{4}{6}\frac{cer^4}{d^4}.$$

Cor. 1. If the particle P is ſituated preciſely in N, the pole of the ſpheroid, the attraction of the ſpheroid is $\frac{2}{3}cr+\frac{8}{15}ce$.

If the ſpheroid is not oblate, but oblong, and if the greater ſemiaxis be r, and the depreſſion at the equator be e, the analyſis is the ſame, taking e negatively. Therefore the attraction for a particle in the pole, or the gravitation of a particle in the pole, is $\frac{2}{3}cr-\frac{8}{15}ce$.

But if the polar ſemiaxis be $r+e$, and the equatorial radius be r, ſo that this oblong ſpheroid has the ſame axis with the former oblate one, the gravitation of a particle in the pole is $\frac{2}{3}cr+\frac{2}{15}ce$.

Cor. 2. If a number of parallel planes are drawn perpendicular to the equator of an oblong ſpheroid, whoſe longer ſemiaxis is $r+e$, and equatorial radius r, they will divide the ſpheroid into a number of ſimilar ellipſes; and ſince the ellipſe through the axis has $r+e$ and r for its two ſemiaxes, and the radius of a circle of equal area with this ellipſe is a mean proportional between r and $r+e$, and therefore very nearly $=r+\frac{1}{2}e$, when e is very ſmall in compariſon of r, a particle on the equator of the oblong ſpheroid will be as much attracted by theſe circles of equal areas, with their correſponding ellipſes, as by the ellipſes. Now the attraction at the pole of an oblate ſpheroid was $\frac{2}{3}cr+\frac{8}{15}ce$. Therefore putting $\frac{1}{2}e$ in place of e, the attraction on the equator of the oblong ſpheroid will be equal to $\frac{2}{3}cr+\frac{4}{15}ce$.

Thus we have aſcertained the gravitations of a particle ſituated in the pole, and of one ſituated in the equator, of a homogeneous oblong ſpheroid. This will enable us to ſolve the following problem:

If the particles of a homogeneous oblong fluid ſpheroid attract each other with a force inverſely as the ſquares of their diſtances, and if they are attracted by a very diſtant body by the ſame law, and if the ratio of the equatorial gravity to this external force be given; to find what muſt be the proportion of the ſemi-axis, ſo that all may be in equilibrio, and the ſpheroid preſerve its form?

Let r be the equatorial radius, and $r+e$ be the polar ſemi-axis. Then the gravitation at the pole m is $\frac{2}{3}cr+\frac{2}{15}ce$, and the gravitation at the equator is $\frac{2}{3}cr+\frac{4}{15}ce$. Now by the gravitation towards the diſtant body placed in the direction of the polar axis, the polar gravitation is diminiſhed, and the equatorial gravitation is increaſed; and the increaſe of the equatorial gravitation is to the diminution of the polar gravitation as NO to 2 mO. Therefore if the whole attraction of the oblong ſpheroid for a particle on its equator be to the force which the diſtant body exerts there, as G to P, and if the ſpheroid is very nearly ſpherical, the abſolute weight at the equator will be $\frac{2}{3}cr+\frac{4}{15}ce+\frac{2}{3}cr\frac{\mathrm{P}}{\mathrm{G}}$. And the abſolute weight at the pole will be $\frac{2}{3}cr+\frac{2}{15}ce-\frac{2}{3}cr\frac{2\,\mathrm{P}}{\mathrm{G}}$. Their difference is $\frac{2}{15}ce+2cr\frac{\mathrm{P}}{\mathrm{G}}$.

Now if we ſuppoſe this ſpheroid to be compoſed of ſimilar concentric ſhells, all the forces will decreaſe in the ſame ratio. Therefore the weight of a particle in a column reaching from the equator to the centre will be to the weight of a ſimilarly ſituated particle of a column reaching from the pole to the centre, as the weight of a particle at the equator to the weight of a particle at the pole. But the whole weights of the two columns muſt be equal, that they may balance each other at the centre. Their lengths muſt therefore be reciprocally as the weights of ſimilarly ſituated particles; that is, the polar ſemi-axis muſt be to the equatorial radius, as the weight of a particle at the equator to the weight of a particle at the pole. Therefore we muſt have $\frac{2}{15}ce+2cr\frac{\mathrm{P}}{\mathrm{G}}:\frac{2}{3}cr+\frac{2}{15}ce-\frac{4}{3}cr\frac{\mathrm{P}}{\mathrm{G}}=e:r$.

Hence we derive $2r\frac{\mathrm{P}}{\mathrm{G}}=\frac{8}{15}e$, or $4\,\mathrm{G}:15\,\mathrm{P}=r:e$. This determines the form of the fluid ſpheroid when the ratio of G to P is given.

It is well known that the gravitation of the moon to the earth is to the diſturbing force of the ſun as 178,725 to 1 very nearly. The lunar gravitation is increaſed as ſhe approaches the earth in the reciprocal duplicate ratio of the diſtances. The diſturbing force of the ſun diminiſhes in the ſimple ratio of the diſtances; therefore the weight of a body on the ſurface of the earth is to the diſturbing force of the ſun on the ſame body, in a ratio compounded of the ratio of 178,725 to 1, the ratio of 3600 to 1, and the ratio of 60 to 1; that is, in the ratio of 38604600 to 1. If the mean radius of the earth be 20934500 feet, the difference of the axis, or the elevation of the pole of the watery ſpheroid produced by the gravitation to the ſun, will be $\frac{15}{4} \times \frac{20934500}{38604600}$ feet, or very nearly $24\frac{1}{2}$ inches. This is the tide produced by the ſun on a homogeneous fluid ſphere.

It is plain, that if the earth conſiſts of a ſolid nucleus of the ſame denſity with the water, the form of the ſolar tide will be the ſame. But if the denſity of the nucleus be different, the form of the tide will be different, and will depend both on the denſity and on the figure of the nucleus.

If the nucleus be of the ſame form as the ſurrounding fluid, the whole will ſtill maintain its form with the ſame proportion of the axis. If the nucleus be ſpherical, its action on the ſurrounding fluid will be the ſame as if all the matter of the nucleus by which it exceeds an equal bulk of the fluid were collected at the centre. In this caſe, the ocean cannot maintain the ſame form: for the action of this central body being proportional to the ſquare of the diſtance inverſely, will augment the gravity of the equatorial fluid more than it augments that of the circumpolar fluid; and the ocean, which was in equilibrio (by ſuppoſition), muſt now become more protuberant at the poles. It may, however, be again balanced in an elliptical form, when it has acquired a juſt proportion of the axes. The proceſs for determining this is tedious, but preciſely ſimilar to the preceding.

If the denſity of the nucleus exceed that of the fluid about $\frac{1}{5\frac{1}{2}}$, we ſhall have $r : e = G : 3\,P$, which is nearly the form which has been determined for the earth, by the menſuration of degrees of the meridian, and by the vibration of pendulums. The curious reader will do well to conſult the excellent diſſertations by Clairaut and Boſcovich on the Figure of the Earth, where this curious problem is treated in the moſt complete manner. Mr Bernoulli, in his diſſertation on the Tides, has committed a great miſtake in this particular. On the other hand, if the nucleus be leſs denſe than the waters, or if there be a great central hollow, the elevation produced by the ſun will exceed $24\frac{1}{2}$ inches.

It is needleſs to examine this any farther. We have collected enough for explaining the chief affections of the tides.

It is known that the earth is not a ſphere, but ſwelled out at the equator by the diurnal rotation. But the change of form is ſo very ſmall in proportion to the whole bulk, that it cannot ſenſibly affect the change of form afterwards induced by the ſun on the waters of the ocean. For the diſturbing force of the ſun would produce a certain protuberance on a fluid ſphere; and this protuberance depends on the ratio of the diſturbing force to the force of gravity at the ſurface of this ſphere. If the gravity be changed in any proportion, the protuberance will change in the ſame proportion. Therefore if the body be a ſpheroid, the protuberance produced at any point by the ſun will increaſe or diminiſh in the ſame proportion that the gravity at this point has been changed by the change of form. Now the change of gravity, even at the pole of the terreſtrial ſpheroid, is extremely ſmall in compariſon with the whole gravity. Therefore the change produced on the ſpheroid will not ſenſibly differ from that produced on the ſphere; and the elevations of the waters above the ſurface, which they would have aſſumed independent of the ſun's action, will be the ſame on the ſpheroid as on the ſphere. For the ſame reaſon, the moon will change the ſurface already changed by the ſun, in the ſame manner as ſhe would have changed the ſurface of the undiſturbed ocean. Therefore the change produced by both theſe luminaries in any place will be the ſame when acting together as when acting ſeparately; and it will be equal to the ſum, or the difference of their ſeparate changes, according as theſe would have been in the ſame or in oppoſite directions.

Let us now conſider the moſt intereſting circumſtances of the form of an elliptical tide, which differs very little from a ſphere.

Let T (fig. 2.) be a point in the ſurface of the inſcribed ſphere, and let Z expreſs the angular diſtance TOQ from the longer axis of the ſurrounding ſpheroid S *m* N *q*. Let TR, TW be perpendicular to the equatorial diameter and to the axis, ſo that they are the coſine and the ſine of TOQ to the radius TO or QO. Let S′ *q* N′ be a ſection of the circumſcribed ſphere. Draw OT cutting the ſpheroid in Z and the circumſcribed ſphere in *t*. Alſo let *s o n* be a ſection of a ſphere which has the ſame capacity with the ſpheroid, and let it cut the radius in *r*. Then, Fig. 2.

1. The elevation TZ of the point Z of the ſpheroid above the inſcribed ſphere is $= Q\,q \times \text{coſ.}^2\,Z$, and the depreſſion *t* Z below the circumſcribed ſphere is $= Q\,q \times \text{ſine}^2\,Z$. Produce RT till it meet the ſurface of the ſpheroid in V. The minute triangle VTZ may be conſidered as rectilineal, right-angled at Z, and therefore ſimilar to OTR. Therefore OT : TR=TV : TZ. But in the ellipſe OQ, or OT : TR=Q *q* : TV. Therefore $OT^2 : TR^2 = Q\,q : TZ$, and $TZ = \frac{Q\,q \cdot TR^2}{OT^2}$,

$$= Q\,q : \frac{Q\,q \times \text{coſ.}^2\,Z}{1}, = Q\,q \times \text{coſ.}^2\,Z.$$

And in the very ſame manner it may be ſhown, that $t\,Z = Q\,q \times \text{ſin.}^2\,Z$.

2. The elevation of the point T above another point T′, whoſe angular diſtance TOT′ from the point T is 90°, is $= Q\,q \times \overline{\text{coſ.}^2\,Z - \text{ſin.}^2\,Z}$. Call the angle QOT′ Z′. Then T′ Z′=Q *q* × coſ.² Z′, and TZ—T′, Z′, $= Q\,q \times \overline{\text{coſ.}^2\,Z - \text{coſ.}^2\,Z'}$. But the arch QT′ is the complement of QT, and therefore $\text{coſ.}^2\,Z' = \text{ſin.}^2\,Z$. Therefore TZ—T′, $Z' = Q\,q \times \overline{\text{coſ.}^2 Z - \text{ſin.}^2\,Z}$.

3. $Q\,o = \frac{1}{3}\,Q\,q$. For the inſcribed ſphere is to the ſpheroid as OQ to O *q*. But the inſcribed ſphere is to the ſphere *s o n* as OQ^3 to $O\,o^3$. Therefore becauſe the ſphere *s o n* is equal to the ſpheroid S *q* N, we have $OQ : O\,q = OQ^3 : O\,o^3$, and O *o* is the firſt of two mean proportionals between OQ and O *q*. But Q *q* is very ſmall in compariſon with OQ. Therefore Q *o* is very nearly $\frac{1}{3}$ of Q *q*.

Since *s o n* is the ſphere of equal capacity, it is the form of the undiſturbed ocean. The beſt way therefore of conceiving the changes of form produced by the ſun or moon, or by both together, is to conſider the elevations or depreſſions which they produce above or below this ſurface. Therefore,

4. The

4. The elevation $r\,Z$ of the point Z above the equicapacious ſphere is evidently $= Q\,q \times \text{coſ.}^2 Z - \frac{1}{3} Q\,q$. Alſo the depreſſion $r'\,Z'$ of the point Z' is $= Q\,q \times \text{ſin.}^2 Z' - \frac{2}{3} Q\,q$.

N. B. Either of theſe formulæ will anſwer for either the elevation above, or the depreſſion below, the natural ocean: For if $\text{coſ.}^2 Z$ is leſs than $\frac{1}{3}$, the elevation given by the formula will be negative; that is, the point is below the natural ſurface. In like manner, when $\text{ſin.}^2 Z'$ is leſs than $\frac{2}{3}$, the depreſſion is negative, and the point is above the ſurface. But if $\text{coſ.}^2 Z$ be $= \frac{1}{3}$, or $\text{ſin.}^2 Z'$ be $= \frac{2}{3}$, the point is in the natural ſurface. This marks the place where the ſpheroid and the equal ſphere interſect each other, viz. in P′, the arch P′ o being 54° 44′ very nearly, and PS=35° 16′.

Let S repreſent the whole elevation of the pole of the ſolar tide above its equator, or the difference between high and low water produced by the ſun; and let M repreſent the whole elevation produced by the moon. Let x and y repreſent the zenith diſtances of the ſun and moon with reſpect to any point whatever on the ocean. Then x and y will be the arches intercepted between that point and the ſummits of the ſolar and lunar tides. Then the elevation produced by both luminaries in that plane is $S \cdot \text{coſ.}^2 x - \frac{1}{3} S + M \cdot \text{coſ.}^2 y - \frac{1}{3} M$; or, more conciſely, $S \cdot \text{coſ.}^2 x + M \cdot \text{coſ.}^2 y - \frac{1}{3} \overline{S+M}$, and the depreſſion is $S \cdot \text{ſin.}^2 x + M \cdot \text{ſin}^2 y - \frac{2}{3} \overline{S+M}$.

Let the ſun and moon be in the ſame point of the heavens. The ſolar and lunar tides will have the ſame axis; the coſines of x and y will each be 1, and the elevation at the compound pole will be $S+M - \frac{1}{3} \overline{S+M} = \frac{2}{3} \overline{S+M}$. The depreſſion at any point 90° from this pole will be $\frac{1}{3} \overline{S+M}$, and the whole tide is $S+M$.

Let the moon be in quadrature, as in a (fig. 3.). The appearance at s will be known, by conſidering that in this place the coſine of x is 1, and the coſine of y is 0. Therefore the elevation at $s = S - \frac{1}{3} \overline{S+M}, = \frac{2}{3} S - \frac{1}{3} M$.
The depreſſion at $a = S - \frac{2}{3} \overline{S+M} = \frac{1}{3} S - \frac{2}{3} M$.
The difference or whole tide $= \overline{S - M}$.
In like manner, the whole elevation at a above the inſcribed ſphere is $M - S$.

Hence we ſee that the whole tide, when the moon is in quadrature, is the difference of S and M. We alſo ſee, that if M exceeds S, the water will be higher at a than at s. Now it is a matter of obſervation, that in the quadratures it is high water under the moon, and low water under the ſun. It is alſo a matter of obſervation, that in the free ocean, the ebb tide, or the water at s, immediately under the ſun, is below the natural ſurface of the ocean. Hence we muſt conclude, that $\frac{2}{3} S$ is leſs than $\frac{1}{3} M$, or that M is more than double of S. This agrees with the phenomena of nutation and preceſſion, which ſeem to make $S = \frac{2}{5}$ of M.

In all other poſitions of the ſun and moon, the place of high water will be different. It is high water where the ſum of the elevations produced by both luminaries above the natural ocean is greateſt; and the place of low water is where the depreſſion below the natural ocean is greateſt. Therefore, in order that it may be high water, we muſt have $S \cdot \text{coſ.}^2 x + M \cdot \text{coſ.}^2 y - \frac{1}{3} \overline{S+M}$ a maximum; or, neglecting the conſtant quantity $\frac{S+M}{3}$, we muſt have $S \cdot \text{coſ.}^2 x + M \cdot \text{coſ.}^2 y$ a maximum.

In like manner, to have low water in a place where the zenith diſtances of the ſun and moon are v and w, we muſt have $S \cdot \text{ſin.}^2 v + M \cdot \text{ſin.}^2 w$ a maximum.

Lemma 1. If we conſider the ſines and coſines of angles as numeral fractions of the radius 1, then we have $\text{coſ.}^2 Z = \frac{1}{2} + \frac{1}{2} \text{coſ.}^2 Z$, and $\text{ſin.}^2 Z = \frac{1}{2} - \frac{1}{2} \text{coſ.}^2 Z$.

Let $a\,m\,s$ (fig. 3.) be a quadrant of a circle of which O is the centre, and $O\,s$ is the radius. On $O\,s$ deſcribe the ſemicircle OMS, cutting $O\,m$ in M. Draw $s\,M$, and produce it till it cut the quadrant in n. Alſo draw MC to the centre of the ſemicircle, and MD and $n\,d$ perpendicular to $O\,s$. Fig. 3.

It is plain that $s\,M$ is perpendicular to OM; and if $O\,s$ be radius, $s\,M$ is the ſine of the angle $s\,OM$, which we may call Z; OM is its coſine: and becauſe $O\,s : OM = OM : OD$, and $O\,s : OD = O\,s^2 : OM^2$, and OD may repreſent $\text{coſ.}^2 Z$. Now $OD = OC + CD$. If $O\,s = 1$, then $OC = \frac{1}{2}$. $CD = CM \cdot \text{coſ. } MCD, = CM \cdot \text{coſ. } 2\,MOD, = \frac{1}{2} \cdot \text{coſ. } 2\,Z$. Therefore $\text{coſ.}^2 Z = \frac{1}{2} + \frac{1}{2} \text{coſ. } 2\,Z$.

In like manner, becauſe $O\,s : s\,M = s\,M : s\,D$, $s\,D$ is $= \text{ſin}^2 Z$. This is evidently $= \frac{1}{2} - \frac{1}{2} \text{coſ. } 2\,Z$.

Lemma 2. $\text{Coſ.}^2 Z - \text{ſin.}^2 Z = \text{coſ. } 2\,Z$. For, becauſe $s\,M$ is perpendicular to OM, the arch $s\,n$ is double of the arch $s\,m$, and becauſe MD is parallel to $n\,d$, $s\,d$ is $= 2\,s\,D$, and $d\,D = \text{ſin.}^2 Z$. Therefore $O\,d = \text{coſ.}^2 Z - \text{ſin.}^2 Z$. But $O\,d$ is the conſine of $n\,s$, $= \text{coſ. } 2\,Z$ and $\text{coſ.}^2 Z - \text{ſin.}^2 Z = \text{coſ. } 2\,Z$.

By the firſt Lemma we ſee, that in order that there may be high water at any place, when the zenith diſtances of the ſun and moon are x and y, we muſt have $S \cdot \text{coſ. } 2x + M \cdot \text{coſ. } 2\,y$ a maximum.

That this may be the caſe, the fluxion of this formula muſt be $= 0$. Now we know that the fluxions of the coſines of two arches are as the ſines of thoſe arches. Therefore we muſt have $S \cdot \text{ſin. } 2x + M \cdot \text{ſin. } 2\,y = 0$, or $S \cdot \text{ſin. } 2x = -M \cdot \text{ſin. } 2\,y$, which gives us $\text{ſin. } 2x : \text{ſin. } 2\,y = M : S$.

In like manner, the place of low water requires $\text{ſin. } 2\,v : \text{ſin. } 2\,w = M : S$.

From this laſt circumſtance we learn, that the place of low water is 0, removed 90° from the place of high water; whereas we might have expected, that the ſpheroid would have been moſt protuberant on that ſide on which the moon is: For the ſines of $2\,v$ and of $2\,w$ have the ſame proportion with the ſines of $2x$ and of $2\,y$. Now we know that the ſine of the double of any arch is the ſame with the ſine of the double of its complement. Therefore if low water be really diſtant 90° from high water, we ſhall have $\text{ſin. } 2x : \text{ſin. } 2y = \text{ſin. } 2v : \text{ſin. } 2\,w$. But if it is at any other place, the ſines cannot have this proportion.

Now let s be the point of the earth's ſurface which has the ſun in the zenith, and m the point which has the moon in the zenith. Let h be any other point. Draw $O\,h$ cutting the ſemicircle $OM\,s$ in H. Make CM to CS as the diſturbing force of the moon to that of the ſun; and draw $S\,v$ parallel, and $S\,t$, $M\,r$ perpendicular to HH′. Join MH and MH′. The angle $HC\,s$ is double of the angle $HO\,s$, and MCH is double of MH′H, or of its equal MOH. Becauſe HMH is a ſemicircle, HM is perpendicular to MO. Therefore

fore if HH' be conſidered as radius, HM is the ſine, and $H'M$ is the coſine of $MH'H$. And Cr is $= MC \cdot \text{coſ. } 2y, = M \cdot \text{coſ. } 2y$. And Ct is $SC \cdot \text{coſ. } 2x$. Therefore tr or $S'v$ is $= S \cdot \text{coſ. } 2x + M \cdot \text{coſ. } 2y$. Therefore tr or Sv will expreſs the whole difference of elevation between h and the points that are 90 degrees from it on either ſide (by *Lemma* 2.); and if h be the place of high water, it will expreſs the whole tide, becauſe the high and low waters were ſhown to be 90° aſunder. But when h is the place of high water, Sv is a maximum. Becauſe the place of the moon, and therefore the point M, is given, Sv will be a maximum when it coincides with SM, and CH is parallel to SM.

This ſuggeſted to us the following new, and not inelegant, ſolution of the problem for determining the place of high water.

Fig. 4. and 5.

Let $sQoqs$ (fig. 4. and 5.) be a ſection of the terraqueous globe, by a plane paſſing through the ſun and moon, and let O be its centre. Let s be the point which is immediately under the ſun, and m the place immediately under the moon. Biſect Os in C, and deſcribe round C the circle $OMsLO$, cutting Om in M. Take Cs to repreſent the diſturbing force of the moon, and make Cs to CS as the force of the moon to that of the ſun (ſuppoſing this ratio to be known). Join MS, and draw CH parallel to it. Draw OHh, and $lOLl'$ perpendicular to it. And laſtly, draw CI perpendicular to SM. Then we ſay that m and its oppoſite m' are the places of high water, l and l' are the places of low water, MS is the height of the tide, and MI, SI are the portions of this tide produced by the moon and ſun.

For it is plain, that in this caſe the line Sv of the laſt propoſition coincides with MS, and is a maximum. We may alſo obſerve, that $MC : CS = \text{ſin. } MSC : \text{ſin. } SMC, = \text{ſin. } HCS : \text{ſin. } MCH, = \text{ſin. } 2hOs : \text{ſin. } 2hOm, = \text{ſin. } 2x : \text{ſin. } 2y$, or $M : S = \text{ſin. } 2x : \text{ſin. } 2y$, agreeably to what was required for the maximum.

It is alſo evident, that $MI = MC \cdot \text{coſ. } CMI, = M \cdot \text{coſ. } 2y$, and $SI = SC \cdot \text{coſ. } ISC, = S \cdot \text{coſ. } 2x$; and therefore MS is the difference of elevation between h and the points l and l', which are 90° from it, and is therefore the place of low water; that is, MS is the whole tide.

The elevation of every other point may be determined in the ſame way, and thus may the form of the ſpheroid be completely determined.

If we ſuppoſe the figure to repreſent a ſection through the earth's equator (which is the caſe when the ſun and moon are in the equator), and farther ſuppoſe the two luminaries to be in conjunction, the ocean is an oblong ſpheroid, whoſe axis is in the line of the ſyzigies, and whoſe equator coincides with the ſix hour circle. But if the moon be in any other point of the equator, the figure of the ocean will be very complicated. It will not be any figure of revolution; becauſe neither its equator (or moſt depreſſed part) nor its meridians are circles. The moſt depreſſed part of its equator will be in that ſection through the axis which is perpendicular to the plane in which the luminaries are ſituated. And this greateſt depreſſion, and its ſhorteſt equatorial diameter, will be conſtant, while its other dimenſions vary with the moon's place. We need not inquire more minutely into its form; and it is ſufficient to know that all the ſections perpendicular to the plane paſſing through the ſun and moon are ellipſes.

This conſtruction will afford us a very ſimple, and, we hope, a very perſpicuous explanation of the chief phenomena of the tides. The well informed reader will be pleaſed with obſerving its coincidence with the algebraic ſolution of the problem given by Daniel Bernoulli, in his excellent diſſertation on the Tides, which ſhared with M'Laurin and Euler the prize given by the Academy of Sciences at Paris, and with the eaſe and perſpicuity with which the phenomena are deducible from it, being in ſome ſort exhibited to the eye.

In our application, we ſhall begin with the ſimpleſt caſes, and gradually introduce the complicating circumſtances which accommodate the theory to the true ſtate of things.

We begin, therefore, by ſuppoſing the earth covered, to a proper depth, with water, forming an ocean concentric with its ſolid nucleus.

In the next place, we ſuppoſe that this ocean adopts in an inſtant the form which is conſiſtent with the equilibrium of gravity and the diſturbing forces.

Thirdly, We ſuppoſe the ſun ſtationary, and the moon to move eaſtward from him above $12\frac{1}{2}°$ every day.

Fourthly, We ſuppoſe that the ſolid nucleus turns round its proper axis to the eaſtward, making a rotation in 24 ſolar hours. Thus any place of obſervation will ſucceſſively experience all the different depths of water.

Thus we ſhall obtain a certain SUCCESSION of phenomena, preciſely ſimilar to the ſucceſſion obſerved in nature, with this ſole difference, that they do not correſpond to the contemporaneous ſituations of the ſun and moon. When we ſhall have accounted for this difference, we ſhall preſume to think that we have given a juſt theory of the tides.

We begin with the ſimpleſt caſe, ſuppoſing the ſun and moon to be always in the equator. Let the ſeries begin with the ſun and moon in conjunction in the line Os. In this caſe the points s, m, and h coincide, and we have high water at 12 o'clock noon and midnight.

While the moon moves from s to Q, Om cuts the upper ſemicircle in M; and therefore CH, which is always parallel to MS, lies between MC and Cs. Therefore h is between m and s, and we have high water after 12 o'clock, but before the moon's ſouthing. The ſame thing happens while the moon moves from o to q, during her third quarter.

But while the moon moves from her firſt quadrature in Q to oppoſition in o (as in fig. 5.), the line mO drawn from the moon's place, cuts the lower ſemicircle in M and CH, parallel to SM, again lies between M and s, and therefore h lies between m and o. The place of high water is to the eaſtward of the moon, and we have high water after the moon's ſouthing. The ſame thing happens while the moon is moving from her laſt quadrature in q to the next ſyzigy. In ſhort, the point H is always between M and s, and the place of high water is always between the moon and the *neareſt* ſyzigy. The place of high water overtakes the moon in each quadrature, and is overtaken by the moon in each ſyzigy. Therefore during the firſt and third quarters, the place of high water gradually falls behind the moon for ſome time, and then gains upon her again, ſo

as

as to overtake her in the next quadrature. But during the ſecond and fourth quarters, the place of high water advances before the moon to a certain diſtance, and then the moon gains upon it, and overtakes it in the next ſyzigy.

If therefore we ſuppoſe the moon to advance uniformly along the equator, the place of high water moves unequally, ſloweſt in the times of new and full moon, and ſwifteſt in the time of the quadratures. There muſt be ſome intermediate ſituations where the place of high water neither gains nor loſes upon the moon, but moves with the ſame velocity.

The rate of motion of the point h may be determined as follows: Draw $C\,i$, $S\,n$, making very ſmall and equal angles with HC and MS. Draw $n\,C$, and about S, with the diſtance $S\,n$, deſcribe the arch $n\,v$, which may be conſidered as a ſtraight line perpendicular to $n\,S$, or to MS.

Then, becauſe SM and $S\,n$ are parallel to CH and $C\,i$, the points n and i are contemporaneous ſituations of M and H, and the arches $n\,M$, $i\,H$, are in the ratio of the angular motions of m and h. Alſo, becauſe $n\,v$ and $n\,M$ are perpendicular to $n\,S$ and $n\,C$, the angle $v\,n\,M$ is equal to the angle $S\,n\,C$, or SMC. Alſo, becauſe the angles $n\,v\,M$ and MIC are right angles, and the angles $v\,n\,M$, CMI, are alſo equal, the triangles $v\,n\,M$, CMI, are ſimilar. Therefore

$n\,M : n\,v = MC : MI$. And

$n\,v : i\,H = n\,S : i\,C$, or $= MS : MC$; therefore

$n\,M : i\,H = MS : MI$. Therefore the angular motion of the moon is to the angular motion of the place of high water as MS to MI.

Therefore, when M'S is perpendicular to SC, and the point I coincides with S, the motion of high water is equal to that of the moon. But when M'S is perpendicular to SC, H'C is alſo perpendicular to $C\,s$, and the angle $h'Os$ is 45°, and the high water is in the octant. While the moon paſſes from s to m', or the high water from s to h', the point I falls between M and S, and the motion of high water is ſlower than that of the moon. The contrary obtains while the moon moves from m' to Q, or the high water from the octant to the quadrature.

It is evident, that the motion of h in the third quarter of the lunation, that is, in paſſing from o to q, is ſimilar to its motion from s to Q. Alſo, that its motion from Q to o muſt retard by the ſame degrees as it accelerated in paſſing from s to Q, and that its motion in the laſt quarter from q to s is ſimilar to its motion from Q to o.

At new and full moon the point I coincides with C, and the point M coincides with s. Therefore the motion of the high water at full and change is to the motion of the moon as $s\,C$ to $s\,S$. But when the moon is in quadrature, I coincides with C, and M with o. Therefore the motion of the moon is to that of high water as OS to OC or $s\,C$. Therefore the motion of high water at full and change is to its motion in the quadratures as OS to $S\,s$, or as the difference of the diſturbing forces to their ſum. The motion of the tide is therefore ſloweſt in the ſyzigies and ſwifteſt in the quadratures; yet even in the ſyzigies it paſſes the ſun along with the moon, but more ſlowly.

Let the interval between the morning tide of one day and that of the next day be called a *tide-day*. This is always greater than a ſolar day, or 24 hours, becauſe the place of high water is moving faſter to the eaſtward than the ſun. It is leſs than a lunar day, or 24h. 50′, while the high water paſſes from the ſecond to the third octant, or from the fourth to the firſt. It is equal to a lunar day when high water is in the octants, and it exceeds a lunar day while high water paſſes from the firſt to the ſecond octant, or from the third to the fourth.

The difference between a ſolar day and a tide day is called the PRIMING or the RETARDATION of the tides. This is evidently equal to the time of the earth's deſcribing in its rotation an angle equal to the motion of the high water in a day from the ſun. The ſmalleſt of theſe retardations is to the greateſt as the difference of the diſturbing forces to their ſum. Of all the phenomena of the tides, this ſeems liable to the feweſt and moſt inconſiderable derangements from local and accidental circumſtances. It therefore affords the beſt means for determining the proportion of the diſturbing forces. By a compariſon of a great number of obſervations made by Dr Maſkelyne at St Helena, and at Barbadoes (places ſituated in the open ſea), it appears that the ſhorteſt tide-day is 24h. 37′, and the longeſt is 25h. 27′. This gives $M-S : M+S = 37 : 87$, and $S : M = 2 : 4.96$; which differs only 1 part in 124 from the proportion of 2 to 5, which Daniel Bernoulli collected from a variety of different obſervations. We ſhall therefore adopt the proportion of 2 to 5 as abundantly exact. It alſo agrees exactly with the phenomena of the nutation of the earth's axis and the preceſſion of the equinoxes; and the aſtronomers affect to have deduced this proportion from theſe phenomena. But an intelligent reader of their writings will perceive more fineſſe than juſtice in this aſſertion. The nutation and preceſſion *do not* afford phenomena of which we can aſſign the ſhare to each luminary with ſufficient preciſion for determining the proportion of their diſturbing forces; and it is by means of many arbitrary combinations, and without neceſſity, that D'Alembert has made out this ratio. We cannot help being of opinion, that D'Alembert has accommodated his diſtribution of the phenomena to this ratio of 2 to 5, which Daniel Bernoulli (the beſt philoſopher and the moſt candid man of that illuſtrious family of mathematicians) had, with ſo much ſagacity and juſtneſs of inference, deduced from the phenomena of the tides. D'Alembert could not but ſee the value of this inference; but he wanted to ſhow his own addreſs in deducing it *proprio marte* forſooth from the nutation and preceſſion. His procedure in this reſembles that of his no leſs vain countryman De la Place, who affects to be highly pleaſed with finding that Mr Bode's diſcovery that Meyer had ſeen the Georgium Sidus in 1756, perfectly agreed with the theory of its motions which he (De la Place) had deduced from his own doctrines. Any well informed mathematician will ſee, that De la Place's data afforded no ſuch preciſion; and the book on the Elliptical Motions of the Planets, to which he alludes, contains no grounds for his inference. This obſervation we owe to the author of a paper on that ſubject in the Tranſactions of the Royal Society of Edinburgh. We hope that our readers will excuſe this occaſional obſervation, by which we wiſh to do juſtice to the merit of a modeſt man, and one of the greateſt philoſophers of his time. Our only claim in the preſent diſſertation is the making his excellent performance

formance on the tides acceſſible to an Engliſh reader not much verſant in mathematical reſearches; and we are ſorry that our limits do not admit any thing more than a ſketch of it. But to proceed.

Aſſuming 2 : 5 as the ratio of SC to CM′, we have the angle $CM'S=23^{\circ}\ 34'$ nearly, and $m'oh'=11^{\circ}\ 47'$; and this is the greateſt difference between the moon's place and the place of high water. And when this obtains, the moon's elongation $m'os$ is $56^{\circ}\ 47'$ from the neareſt ſyzigy. Hence it follows, that while the moon moves uniformly from $56^{\circ}\ 47'$ weſt elongation to $56^{\circ}\ 47'$ eaſt, or from $123^{\circ}\ 13'$ eaſt to $123^{\circ}\ 13'$ weſt, the tide day is ſhorter than the lunar day; and while ſhe moves from $56^{\circ}\ 47'$ eaſt to $123^{\circ}\ 13'$, or from $123^{\circ}\ 13'$ weſt to $56^{\circ}\ 47'$, the tide-day is longer than the lunar-day.

We now ſee the reaſon why

———The ſwelling tides obey the moon.

The time of high water, when the ſun and moon are in the equator, is never more than 47 minutes different from that of the moon's ſouthing (+ or — a certain fixed quantity, to be determined once for all by obſervation).

It is now an eaſy matter to determine the hour of high water correſponding to any poſition of the ſun and moon in the equator. Suppoſe that on the noon of a certain day the moon's diſtance from the ſun is ms. The conſtruction of this problem gives us sh, and the length of the tide-day. Call this T. Then ſay $360^{\circ} : sm = T : t$, and t is the hour of high water.

Or, if we chooſe to refer the time of high water to the moon's ſouthing, we muſt find the value of mh at the time of the moon's ſouthing, and the difference d between the tide-day and a mean lunar day L, and ſay $360 : mh = d : \delta$, the time of high water before the moon's ſouthing in the firſt and third quarters, but after it in the ſecond and fourth. The following table by Daniel Bernoulli exhibits theſe times for every 10th degree of the moon's elongation from the ſun. The firſt or leading column is the moon's elongation from the ſun or from the point of oppoſition. The ſecond column is the minutes of time between the moon's ſouthing and the place of high water. The marks — and + diſtinguiſh whether the high water is before or after the moon's ſouthing. The third column is the hour and minute of high water. But we muſt remark, that the firſt column exhibits the elongation, not on the noon of any day, but at the very time of high water. The two remaining columns expreſs the heights of the tides and their daily variations.

m s.	*m h.*	*s h.*	M S.	M *v.*
°	′	h. ′		
0	0	0. 0	1000	
	—			13
10	11½—	0.28½	987	38
20	22 —	0.58	949	62
30	31½—	1.28½	887	81
40	40 —	2.—	806	91
50	45 —	2.35	715	105
60	46½—	3.13½	610	92
70	40½—	3.59½	518	65
80	25 —	4.55	453	24
90	0	6.—	429	—
	+			24
100	25 +	7. 5	453	65
110	40½+	8. 0½	518	92
120	46½+	8.46½	610	105
130	45 +	9.25	715	91
140	40 +	10.—	806	81
150	31½+	10.31½	887	6
160	22 +	11. 2	949	38
170	11½+	11.31½	987	13
180	0	12.—	1000	

The height of high water above the low water conſtitutes what is uſually called the tide. This is the intereſting circumſtance in practice. Many circumſtances render it almoſt impoſſible to ſay what is the elevation of high water above the natural ſurface of the ocean. In many places the ſurface at low water is above the natural ſurface of the ocean. This is the caſe in rivers at a great diſtance from their mouths. This may appear abſurd, and is certainly very paradoxical; but it is a fact eſtabliſhed on the moſt unexceptionable authority. One inſtance fell under our own obſervation. The low-water mark at ſpring tide in the harbour of Alloa was found by accurate levelling to be three feet higher than the top of the ſtone pier at Leith, which is ſeveral feet above the high-water mark of this harbour. A little attention to the motion of running waters will explain this completely. Whatever checks the motion of water in a canal muſt raiſe its ſurface. Water in a canal runs only in conſequence of the declivity of this ſurface: (See RIVER). Therefore a flood tide coming to the mouth of a river checks the current of its waters, and they accumulate at the mouth. This checks the current farther up, and therefore the waters accumulate there alſo; and this checking of the ſtream, and conſequent riſing of the waters, is gradually communicated up the river to a great diſtance. The water riſes everywhere, though its ſurface ſtill has a ſlope. In the mean time, the flood tide at the mouth paſſes by, and an ebb ſucceeds. This muſt accelerate even the ordinary courſe of the river. It will more remarkably accelerate the river now raiſed above its ordinary level, becauſe the declivity at the mouth will be ſo much greater. Therefore the waters near the mouth, by accelerating, will ſink in their channel, and increaſe the declivity of the canal beyond them. This will accelerate the waters beyond them; and thus a ſtream more rapid than ordinary will be produced along the whole river,

river, and the waters will ſink below their ordinary level. Thus there will be an ebb below the ordinary ſurface as well as a flood above it, however ſloping that ſurface may be.

Hence it follows, that we cannot tell what is the natural ſurface of the ocean by any obſervations made in a river, even though near its mouth. Yet even in rivers we have regular tides, ſubjected to all the varieties deduced from this theory.

We have ſeen that the tide is always proportional to MS. It is greateſt therefore when the moon is in conjunction or oppoſition, being then S*s*, the ſum of the ſeparate tides produced by the ſun and moon. It gradually decreaſes as the moon approaches to quadrature; and when ſhe is at Q or *q*, it is SO, or the difference of the ſeparate tides. Suppoſing S*s* divided into 1000 equal parts, the length of MS is expreſſed in theſe parts in the fourth column of the foregoing table, and their differences are expreſſed in the fifth column.

We may here obſerve, that the variations of the tides in equal ſmall times are proportional to the ſine of twice the diſtance of the place of high water from the moon. For ſince M*n* is a conſtant quantity, on the ſuppoſition of the moon's uniform motion, M*v* is proportional to the variation of MS. Now $\mathrm{M}n : \mathrm{M}v = \mathrm{MC} : \mathrm{CI} = 1 : \text{ſin. } 2y$, and M*n* and MC are conſtant quantities.

Thus we have ſeen with what eaſe the geometrical conſtruction of this problem not only explains all the intereſting circumſtances of the tides, but alſo points them out, almoſt without employing the judgement, and exhibits to the eye the gradual progreſs of each phenomenon. In theſe reſpects it has great advantages over the very elegant algebraic analyſis of Mr Bernoulli. In that proceſs we advance almoſt without ideas, and obtain our ſolutions as detached facts, without perceiving their regular ſeries. This is the uſual pre-eminence of geometrical analyſis; and we regret that Mr Bernoulli, who was eminent in this branch, did not rather employ it. We doubt not but that he would have ſhown ſtill more clearly the connection and gradual progreſs of every particular. His aim, however, being to inſtruct thoſe who were to calculate tables of the different affections of the tides, he adhered to the algebraic method. Unfortunately it did not preſent him with the eaſieſt formulæ for practice. But the geometrical conſtruction which we have given ſuggeſts ſeveral formulæ which are exceedingly ſimple, and afford a very ready mode of calculation.

The fundamental problems are to determine the angle *s*O*h* or *m*O*h*, having *m*O*s* given; and to determine MS.

Let the given angle *m*O*s* be called *a*; and, to avoid the ambiguity of algebraic ſigns, let it always be reckoned from the neareſt ſyzigy, ſo that we may always have *a* equal to the ſum of *x* and *y*. Alſo make $d^2 = \frac{\mathrm{S}^2 \times \text{ſin.}^2\, 2a}{\mathrm{M}^2 + \mathrm{S}^2 + 2\mathrm{M} \times \mathrm{S} \times \text{coſ. } 2a}$, which repreſents the $\frac{\mathrm{S}c^2}{\mathrm{S\,M}^2}$ of fig. 4. or $\text{ſin.}^2\, 2y$, and make $p = \frac{\mathrm{S} \times \text{ſin. } 2a}{\mathrm{M} + \mathrm{S} \times \text{coſ. } 2a}$, which is the expreſſion of $\frac{\mathrm{S}\dot{c}}{\mathrm{M}c}$ of that figure, or of tan. $2y$. Then we ſhall have,

1. $\text{Sin. } y = \sqrt{\frac{1 - \sqrt{1 - d^2}}{2}}$. For we ſhall have coſ. $2y = \sqrt{1 - d^2}$. But $\text{ſin.}^2\, y = \frac{1}{2} - \frac{1}{2}\text{coſ. } 2y = 1 - \frac{\sqrt{1 - d^2}}{2}$, and $\text{ſin. } y = \sqrt{\frac{1 - \sqrt{1 - d^2}}{2}}$.

2. $\text{Tan. } y = \frac{p}{1 + \sqrt{1 + p^2}}$. For becauſe p is $=$ tan. $2y$, $\sqrt{1 + p^2}$ is the ſecant of $2y$, and $1 + \sqrt{1 + p^2} : 1 = p : \text{tan. } y$.

Theſe proceſſes for obtaining *y* directly are abundantly ſimple. But it will be much more expeditious and eaſy to content ourſelves with obtaining $2y$ by means of the value of its tangent, viz. $\frac{\mathrm{S} \cdot \text{ſin. } 2a}{\mathrm{M} + \mathrm{S} \cdot \text{coſ. } 2a}$. Or, we may find *x* by means of the ſimilar value of its tangent $\frac{\mathrm{M}d}{\mathrm{S}d}$ of fig. 4.

There is ſtill an eaſier method of finding both $2x$ and $2y$, as follows.

Make $\mathrm{M} + \mathrm{S} : \mathrm{M} - \mathrm{S} = \text{tan. } a : \text{tan. } b$. Then *b* is the difference of *x* and *y*, as *a* is their ſum. For this analogy evidently gives the tangent of half the difference of the angles CSM and CMS of fig. 4. or of $2x$ and $2y$. Therefore to *a*, which is half the ſum of $2x + 2y$, add *b*, and we have $2x = a + b$, or $x = \frac{a+b}{2}$, and $y = \frac{a-b}{2}$.

By either of theſe methods a table may be readily computed of the value of *x* or *y* for every value of *a*.

But we muſt recollect that the values of S and M are by no means conſtant, but vary in the inverſe triplicate ratio of the earth's diſtance from the ſun and moon; and the ratio of 2 to 5 obtains only when theſe luminaries are at their mean diſtances from the earth. The forces correſponding to the perigean, medium, and apogean diſtances are as follow.

		Sun.	Moon.
Apogean	-	1.901	4.258
Medium	-	2.	5.
Perigean	-	2.105	5.925

Hence we ſee that the ratio of S to M may vary from 1.901 : 5.925 to 2.105 : 4.258, that is, nearly from 1 : 3 to 1 : 2, or from 2 : 6 to 2 : 4. The ſolar force does not vary much, and may be retained as conſtant without any great error. But the change of the moon's force has great effects on the tides both as to their time and their quantity.

I. In reſpect of their Time.

1. The tide day following a ſpring tide is 24 h. 27′ when the moon is in perigee, but 24 h. 33′ when ſhe is in apogee.

2. The tide day following neap tide is 25 h. 15′, and 25 h. 40′ in theſe two ſituations of the moon.

3. The greateſt interval of time between high water and the moon's ſouthing is 39′ and 61′; the angle

y being 9° 45′ in the firſt caſe, and 15° 15′ in the ſecond.

II. In reſpect of their Heights.

1. If the moon is in perigee when new or full, the ſpring tide will be 8 feet inſtead of 7, which correſponds to her mean diſtance. The very next ſpring tide happens when ſhe is near her apogee, and will be 6 feet inſtead of 7. The neap tides happen when ſhe is at her mean diſtance, and will therefore be 3 feet.

But if the moon be at her mean diſtance when new or full, the two ſucceeding ſpring tides will be regular or 7 feet, and one of the neap tides will be 4 feet and the other only 2 feet.

Mr Bernoulli has given us the following table of the time of high water for theſe three chief ſituations of the moon, namely, her perigee, mean diſtance, and apogee. It may be had by interpolation for all intermediate poſitions with as great accuracy as can be hoped for in phenomena which are ſubject to ſuch a complication of diſturbances. The firſt column contains the moon's elongation from the ſun. The columns P, M, A, contain the minutes of time which elapſe between the moon's ſouthing and high water, according as ſhe is in perigee, at her mean diſtance, or in apogee. The ſign — indicates the priority, and + the poſteriority, of high water to the moon's ſouthing.

☽ and ⊙	P.	M.	A.
0	0	0	0
	—	—	—
10	9½	11½	14
20	18	22	27½
30	26	31½	39½
40	33	40	50
50	37½	45	56
60	38½	46½	58
70	33½	40½	50½
80	22	25	31
90	0	0	0
	+	+	+
100	21	25	31
110	33½	40½	50½
120	38½	46½	58
130	37½	45	56
140	33	40	50
150	26	31½	39½
160	18	22	27½
170	9½	11½	14
180	0	0	0

The reader will undoubtedly be making ſome compariſon in his own mind of the deductions from this theory with the actual ſtate of things. He will find ſome conſiderable reſemblances; but he will alſo find ſuch great differences as will make him very doubtful of its juſtneſs. In very few places does the high water happen within three-fourths of an hour of the moon's ſouthing, as the theory leads him to expect; and in no place whatever does the ſpring tide fall on the day of new and full moon, nor the neap tide on the day of her quadrature. Theſe always happen two or three days later. By comparing the difference of high water and the moon's ſouthing in different places, he will hardly find any connecting principle. This ſhows evidently that the cauſe of this irregularity is local, and that the juſtneſs of the theory is not affected by it. By conſidering the phenomena in a navigable river, he will learn the real cauſe of the deviation. A flood tide arrives at the mouth of a river. The true theoretical tide differs in no reſpect from a wave. Suppoſe a ſpring tide actually formed on a fluid ſphere, and the ſun and moon then annihilated. The elevation muſt ſink, preſſing the under waters aſide, and cauſing them to riſe where they were depreſſed. The motion will not ſtop when the ſurface comes to a level; for the waters arrived at that poſition with a motion continually accelerated. They will therefore paſs this poſition as a pendulum paſſes the perpendicular, and will riſe as far on the other ſide, forming a high water where it was low water, and a low water where it was high water; and this would go on for ever, oſcillating in a time which mathematicians can determine, if it were not for the viſcidity, or ſomething like friction, of the waters. If the ſphere is not fluid to the centre, the motion of this wave will be different. The elevated waters cannot ſink without diffuſing themſelves ſidewiſe, and occaſioning a great horizontal motion, in order to fill up the hollow at the place of low water. This motion will be greateſt about half way between the places of high and low water. The ſhallower we ſuppoſe the ocean, the greater muſt this horizontal motion be. The reſiſtance of the bottom (though perfectly ſmooth and even) will greatly retard it all the way to the ſurface. Still, however, it will move till all be level, and will even move a little farther, and produce a ſmall flood and ebb where the ebb and flood had been. Then a contrary motion will obtain; and after a few oſcillations, which can be calculated, it will be inſenſible. If the bottom of the ocean (which we ſtill ſuppoſe to cover the whole earth) be uneven, with long extended valleys running in various directions, and with elevations reaching near the ſurface, it is evident that this muſt occaſion great irregularities in the motion of the undermoſt waters, both in reſpect of velocity and direction, and even occaſion ſmall inequalities on the ſurface, as we ſee in a river with a rugged bottom and rapid current. The deviations of the under currents will drag with them the contiguous incumbent waters, and thus occaſion greater ſuperficial irregularities.

Now a flood arriving at the mouth of a river, muſt act preciſely as this great wave does. It muſt be propagated up the river (or along it, even though perfectly level) in a certain time, and we ſhall have high water at all the different places in ſucceſſion. This is diſtinctly ſeen in all rivers. It is high water at the mouth of the Thames at three o'clock, and later as we go up the river, till at London bridge we have not high water till three o'clock in the morning, at which time it is again high water at the Nore. But, in the mean time, there has been low water at the Nore, and high water about half way to London; and while the high water is proceeding to London, it is ebbing at this intermediate place, and is low water there when it is high water at London and at the Nore. Did the tide extend as far beyond London as London is from the Nore, we ſhould have three high waters with two low waters interpoſed. The moſt remarkable inſtance of this kind is the Maragnon or Amazon river in South America. It appears by the obſervations of Condamine and others, that between Para, at the mouth of the river, and the conflux of the Madera and Maragnon, there are ſeven coexiſtent high waters, with ſix low waters between them. Nothing can more evidently ſhow that the tides in theſe places are nothing but the propagation of a wave. The velocity of its ſuperficial motion, and the diſtance to which it will ſenſibly go, muſt depend on many circumſtances. A deep channel and gentle acclivity will allow it to proceed much farther up the river, and the diſtance between the ſucceſſive ſummits will be greater than when the channel is ſhallow and ſteep. If we apply the ingenious theory of Chevalier Buat, delivered in the article RIVER, we may tell both the velocity of the motion and the interval of the ſucceſſive high waters. It may be imitated in artificial canals, and experiments of this kind would be very inſtructive. We have ſaid enough at preſent for our purpoſe of explaining the irregularity of the times of high water in different places, with reſpect to the moon's ſouthing. For we now ſee clearly, that ſomething of the ſame kind muſt happen in all great arms of the ſea which are of an oblong ſhape, and communicate by one end with the open ocean. The general tide in this ocean muſt proceed along this channel, and the high water will happen on its ſhores in ſucceſſion. This alſo is diſtinctly ſeen. The tide in the Atlantic ocean produces high water at new and full moon at a later and later hour along the ſouth coaſt of Great Britain in proportion as we proceed from Scilly iſlands to Dover. In the ſame manner it is later and later as we come along the eaſt coaſt from Orkney to Dover. Yet even in this progreſs there are conſiderable irregularities, owing to the ſinuoſities of the ſhores, deep indented bays, prominent capes, and extenſive ridges and valleys in the channel. A ſimilar progreſs is obſerved along the coaſts of Spain and France, the tide advancing gradually from the ſouth, turning round Cape Finiſterre, ranging along the north coaſt of Spain, and along the weſt and north coaſts of France.

The attentive conſideration of theſe facts will not only ſatisfy us with reſpect to this difficulty, but will enable us to trace a principle of connection amidſt all the irregularities that we obſerve.

We now add, that if we note the difference between the time of high water of ſpring tide, as given by theory, for any place, and the *obſerved time* of high water, we ſhall find this interval to be very nearly conſtant through the whole ſeries of tides during a lunation. Suppoſe this interval to be 40 hours. We ſhall find every other phenomenon ſucceed after the ſame interval. And if we ſuppoſe the moon to be in the place where ſhe was 40 hours before, the obſervation will agree pretty well with the theory, as to the ſucceſſion of tides, the length of tide day, the retardations of the tides, and their gradual diminution from ſpring to neap tide. We ſay pretty well; for there ſtill remain ſeveral ſmall irregularities, different in different places, and not following any obſervable law. Theſe are therefore local, and owing to local cauſes. Some of theſe we ſhall afterwards point out. There is alſo a general deviation of the theory from the real ſeries of tides. The neap tides, and thoſe adjoining, happen a little earlier than the corrected theory points out. Thus at Breſt (where more numerous and accurate obſervations have been made than at any other place in Europe), when the moon changes preciſely at noon, it is high water at 3 h. 28′. When the moon enters her ſecond quarter at noon, it is high water at 8 h. 40′, inſtead of 9 h. 48′, which theory aſſigns.

Something ſimilar, and within a very few minutes equal, to this is obſerved in *every* place on the ſea-coaſt. This is therefore ſomething general, and indicates a real defect in the theory.

But this ariſes from the ſame cauſe with the other general deviation, viz. that the greateſt and leaſt tides do not happen on the days of full and half moon, but a certain time after. We ſhall attempt to explain this.

We ſet out with the ſuppoſition, that the water acquired in an inſtant the elevation competent to its equilibrium. But this is not true. No motion is inſtantaneous, however great the force; and every motion and change of motion produced by a ſenſible or finite force increaſes from nothing to a ſenſible quantity by infinitely ſmall degrees. Time elapſes before the body can acquire any ſenſible velocity; and in order to acquire the ſame ſenſible velocity by the action of different forces acting ſimilarly, a time muſt elapſe inverſely proportional to the force. An infinitely ſmall force requires a finite time for communicating even an infinitely ſmall velocity; and a finite force, in an infinitely ſmall time, communicates only an infinitely ſmall velocity; and if there be any kind of motion which changes by inſenſible degrees, it requires a finite force to prevent this change. Thus a bucket of water, hanging by a cord lapped round a light and eaſily moveable cylinder, will run down with a motion uniformly accelerated; but this motion will be prevented by hanging an equal bucket on the other ſide, ſo as to act with a finite force. This force prevents only infinitely ſmall accelerations.

Now let ALKF (fig. 6.) be the ſolid nucleus of the Fig. 6. earth, ſurrounded by the ſpherical ocean *b h d g*. Let this be raiſed to a ſpheroid BHDG by the action of the moon at M, or in the direction of the axis CM. If all be at reſt, this ſpheroid may have the form preciſely competent to its equilibrium. But let the nucleus, with its ſpheroidal ocean, have a motion round C in the direction AFKL from weſt to eaſt. When the line of water BA is carried into the ſituation *s q* infinitely near to BA, it is no longer in equilibrio; for *s* is too elevated, and the part now come to B is too much depreſſed. There is a force tending to depreſs the waters at *s*, and to raiſe thoſe now at B; but this force is infinitely ſmall. It cannot therefore reſtore the ſhape competent to equilibrium till a ſenſible time has elapſed; therefore the diſturbing force of the moon cannot keep the ſummit of the ocean in the line MC. The force muſt be of a certain determinate magnitude before it can in an inſtant undo the inſtantaneous effect of the rotation of the waters and keep the ſummit of the ocean in the ſame place. But this effect is poſſible; for the depreſſion at *s* neceſſary for this purpoſe is nearly as the diſtance from B, being a depreſſion, not from a ſtraight line, but from a circle deſcribed with the radius CB. It is therefore an infiniteſimal of the firſt order, and may be reſtored in an inſtant, or the continuation of the depreſſion

preſſion prevented by a certain finite force. Therefore there is ſome diſtance, ſuch as B y, where the diſturbing force of the moon may have the neceſſary intenſity. Therefore the ſpherical ocean, inſtead of being kept continually accumulated at B and D, as the waters turn round, will be kept accumulated at y and y', but at a height ſomewhat ſmaller. It is much in this way that we keep melted pitch or other clammy matter from running off from a bruſh, by continually turning it round, and it hangs protuberant, not from the loweſt point, but from a point beyond it, in the direction of its motion. The facts are very ſimilar. The following experiment will illuſtrate this completely, and is quite a parallel fact. Conceive GDH, the lower half of the ellipſe, to be a ſupple heavy rope or chain hanging from a roller with a handle. The weight of the rope makes it hang in an oblong curve, juſt as the force of the moon raiſes the waters of the ocean. Turn the roller very ſlowly, and the rope, unwinding at one ſide and winding up on the other ſide of the roller, will continue to form the ſame curve: but turn the roller very briſkly in the direction FKL, and the rope will now hang like the curve $u\,y'\,v$, conſiderably advanced from the perpendicular, ſo far, to wit, that the force of gravity may be able in an inſtant to undo the infinitely ſmall elevation produced by the turning.

We are very anxious to have this circumſtance clearly conceived, and its truth firmly eſtabliſhed; becauſe we have obſerved it to puzzle many perſons not unaccuſtomed to ſuch diſcuſſions: we therefore hope that our readers, who have got over the difficulty, will indulge us while we give yet another view of this matter, which leads to the ſame concluſion.

It is certain that the interval between high and low water is not ſufficient for producing all the accumulation neceſſary for equilibrium in an ocean ſo very ſhallow. The horizontal motion neceſſary for gathering together ſo much water along a ſhallow ſea would be prodigious. Therefore it never attains its full height; and when the waters, already raiſed to a certain degree, have paſſed the ſituation immediately under the moon, they are ſtill under the action of accumulating forces, although theſe forces are now diminiſhed. They will continue riſing, till they have ſo far paſt the moon, that their ſituation ſubjects them to depreſſing forces. If they have acquired this ſituation with an accelerated motion, they will riſe ſtill farther by their inherent motion, till the depreſſing forces have deſtroyed all their acceleration, and then they will begin to ſink again. It is in this way that the nutation of the earth's axis produces the greateſt inclination, not when the inclining forces are greateſt, but three months after. It is thus that the warmeſt time of the day is a conſiderable while after noon, and that the warmeſt ſeaſon is conſiderably after midſummer. The warmth increaſes till the momentary waſte of heat exceeds the momentary ſupply. We conclude by ſaying, that it may be demonſtrated, that, in a ſphere fluid to the centre, the time of high water cannot be leſs, and may be more, than three lunar hours after the moon's ſouthing. As the depth of the ocean diminiſhes, this interval alſo diminiſhes.

It is perhaps impoſſible to aſſign the diſtance B y at which the ſummit of the ocean may be kept while the earth turns round its axis. We can only ſee, that it muſt be leſs when the accumulating force is greater, and therefore leſs in ſpring tides than in neap tides; but the difference may be inſenſible. All this depends on circumſtances which we are little acquainted with: many of theſe circumſtances are local; and the ſituation of the ſummit of the ocean, with reſpect to the moon, may be different in different places.

Nor have we been able to determine theoretically what will be the height of the ſummit. It will certainly be leſs than the height neceſſary for perfect equilibrium. Daniel Bernoulli ſays, that, after very attentive conſideration, he is convinced that the height at new or full moon will be to the theoretical height as the coſine of the angle BCy to radius, or that the height at y will be $Bb \times \frac{C\alpha}{Cb}$.

The reſult of all this reaſoning is, that we muſt always ſuppoſe the ſummit of the tide is at a certain diſtance eaſtward from the place aſſigned by the theory. Mr Bernoulli concludes, from a very copious compariſon of obſervations at different places, that the place of high water is about 20 degrees to the eaſtward of the place aſſigned by the theory. Therefore the table formerly given will correſpond with obſervation, if the leading column of the moon's elongation from the ſun be altered accordingly. We have inſerted it again in this place, with this alteration, and added three columns for the times of high water. Thus changed it will be of great uſe.

We have now an explanation of the acceleration of the neap tides, which ſhould happen 6 hours later than the ſpring tides. They are in fact tides correſponding to poſitions of the moon, which are 20° more, and not the real ſpring and neap tides. Theſe do not happen till two days after; and if the really greateſt and leaſt tides be obſerved, the leaſt will be found 6 hours later than the firſt.

Elong. of Moon.	High Water before or after Moon's Southing.			Time of High Water.		
	Perigee	M. Diſt.	Apogee.	Perigee.	M. Diſt	Apogee.
0	18 after	22 after	27½ after	0.18	0.22	0.27½
10	9½ do.	11½	14	0.49½	0.51½	0.54
20	0 do.	0	0	1.20	1.20	1.20
30	9½ bef.	11½ bef.	14 bef.	1.50½	1.48	1.46
40	18 do.	22	27½	2.22	2 18	2.12
50	26	31½	39½	2.54	2.48	2 40
60	33	40	50	3.27	3.20	3 10
70	37½	45	56	4.02½	3.55	3.44
80	38½	46½	58	4.41½	4.33	4.22
90	33½	40½	50½	5.26½	5.19	5.09
100	22	25	31	6.19	6.15	6.09
110	0	0	0	7.20	7.20	7.20
120	22 after	25 after	31 after	8.21	8.25	8.31
130	33½ after	40½	50½	9.13½	9.20	9.30
140	38½	46½	58	9.58½	10.06	10.18
150	37½	45	56	10.37½	10.45	10.56
160	33	40	50	11.13	11.20	11.30
170	26	31½	29½	11.46	11.51	11.59
180	18	22	27½	0.18	0.22	0.27

This table is general, and exhibits the time of high water,

water, and their difference from thoſe of the moon's ſouthing, in the open ſea, from all local obſtructions. If therefore the time of high water in any place on the earth's equator (for we have hitherto conſidered no other) be different from this table (ſuppoſed correct), we muſt attribute the difference to the diſtinguiſhing circumſtances of the ſituation. Thus every place on the equator ſhould have high water on the day that the moon, ſituated at her mean diſtance, changes preciſely at noon, at 22 minutes paſt noon; becauſe the moon paſſes the meridian along with the ſun by ſuppoſition. Therefore, to make uſe of this table, we muſt take the difference between the firſt number of the column, intitled time of high water, from the time of high water at full and change peculiar to any place, and add this to all the numbers of that column. This adapts the table to the given place. Thus, to know the time of high water at Leith, when the moon is 50° eaſt of the ſun, at her mean diſtance from the earth, take 22′ from 4h. 30′, there remains 4.08. Add this to 2h. 48′ and we have 6° 56′ for the hour of high water. The hour of high water at new and full moon for Edinburgh is marked 4h. 30′ in Maſkelyne's tables, but we do not pretend to give it as the exact determination. This would require a ſeries of accurate obſervations.

It is by no means an eaſy matter to aſcertain the time of high water with preciſion. It changes ſo very ſlowly, that we may eaſily miſtake the exact minute. The beſt method is to have a pipe with a ſmall hole near its bottom, and a float with a long graduated rod. The water gets in by the ſmall hole, and raiſes the float, and the ſmallneſs of the hole prevents the ſudden and irregular ſtarts which waves would occaſion. Inſtead of obſerving the moment of high water, obſerve the height of the rod about half an hour before, and wait after high water till the rod comes again to that height. Take the middle between them. The water riſes ſenſibly half an hour before the top of the tide, and quickly changes the height of the rod, ſo that we cannot make a great miſtake in the time.

Mr Bernoulli has made a very careful compariſon of the theory thus corrected, with the great collection of obſervations preſerved in the *Depot de la Marine* at Breſt and Rochefort *; and finds the coincidence very great, and far exceeding any rule which he had ever ſeen. Indeed we have no rules but what are purely empirical, or which ſuppoſe a uniform progreſſion of the tides.

The heights of the tides are much more affected by local circumſtances than the regular ſeries of their times. The regular ſpring tide ſhould be to the neap tide in the ſame proportion in all places; but nothing is more different than this proportion. In ſome places the ſpring tide is not double of the neap tide, and in other places it is more than quadruple. This prevented Bernoulli from attempting to fix the proportion of M to S by means of the heights of the tides. Newton had, however, done it by the tides at Briſtol, and made the lunar force almoſt five times greater than the ſolar force. But this was very ill-founded, for the reaſon now given.

Yet Bernoulli ſaw, that in all places the tides gradually decreaſed from the ſyzigies to the quadratures. He therefore preſumed, that they decreaſed by a ſimilar law with the theoretical tides, and has given a very ingenious method of accommodating the theory to any tides which may be obſerved. Let A be the ſpring tide, and B the neap tide in any place. Then form an M and an S from theſe, by making $M = \frac{A+B}{2}$, and $S = \frac{A-B}{2}$; ſo that $M + S$ may be $= A$, and $M - S = B$ agreeable to the theory. Then with this M and S compoſe the general tide T, agreeable to the conſtruction of the problem. We may be perſuaded that the reſult cannot be far from the truth. The following table is calculated for the three chief diſtances of the moon from the earth.

Elong. ☽ & ☉.	Height of the Tide.		
	Moon in Perigee.	Moon in M. Diſt.	Moon in Apogee.
0	0.99A+0.15B	0.88A+0.12B	0.79A+0.08B
10	1.10A+0.04B	0.97A+0.03B	0.87A+0.02B
20	1.14A+0.00B	1.00A+0.00B	0.90A+0.00B
30	1.10A+0.04B	0.97A+0.03B	0.87A+0.02B
40	0.99A+0.15B	0.88A+0.12B	0.79A+0.08B
50	0.85A+0.32B	0.75A+0.25B	0.68A+0.18B
60	0.67A+0.53B	0.59A+0.41B	0.53A+0.29B
70	0.46A+0.75B	0.41A+.059B	0.37A+0.41B
80	0.28A+0.96B	0.25A+0.75B	023A.+0.53B
90	0.13A+1.13B	0.12A+0.88B	0.11A+0.62B
100	0.03A+1.24B	0.03A+0.97B	0.03A+0.68B
110	0.00A+1.28B	0.00A+1.00B	0.00A+0.70B
120	0.03A+1.24B	0.03A+0.97B	0.03A+0.68B
130	0.13A+1.13B	0.12A+0.88B	0.11A+0.62B
140	0.28A+0.96B	0.25A+0.75B	0.23A+0.53B
150	0.46A+0.75B	0.41A+0.59B	0.37A+0.41B
160	0.67A+0·53B	0.59A+0.41B	0.53A+0.29B
170	0.85A+0.32B	0.75A+0.25B	0.68A+0.18B
180	0.99A+0.15B	0.88A+0.12B	0.79A+0.08B

Obſerve that this table is corrected for the retardation ariſing from the inertia of the waters. Thus when the moon is 20 degrees from the ſun, the mean diſtance tide is 1.00A+0.00B, which is the theoretical tide correſponding to conjunction or oppoſition.

We have now given in ſufficient detail the phenomena of the tides along the equator, when the ſun and moon are both in the equator, ſhewing both their times and their magnitude. When we recollect that all the ſections of an oblong ſpheroid by a plane paſſing through an equatorial diameter are ellipſes, and that the compound tide is a combination of two ſuch ſpheroids, we perceive that every ſection of it through the centre, and perpendicular to the plane in which the ſun and moon are ſituated, is alſo an ellipſe, whoſe ſhorter axis is the equatorial diameter of a ſpring tide. This is the greateſt depreſſion in all ſituations of the luminaries; and the points of greateſt depreſſion are the lower poles of every compound tide. When the luminaries are in the equator, theſe lower poles coincide with the poles of the earth. The equator, therefore, of every compound tide is alſo an ellipſe: the whole circumference of which is lower than any other ſection of this tide, and gives the place of low water in every part of the earth. In like manner, the ſection through the four poles, upper and lower, gives the place of high water. Theſe two ſections are terreſtrial meridians or hour circles, when the luminaries are in the equator.

Hence

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* See Mr Caſſini, *Mem. Acad. Par.* 1734.

Hence it follows, that all we have already ſaid as to the times of high and low water may be applied to every place on the ſurface of the earth, when the ſun and moon are in the equator. But the heights of tide will diminiſh as we recede from the equator. The heights muſt be reduced in the proportion of radius to the coſine of the latitude of the place. But in every other ſituation of the ſun and moon all the circumſtances vary exceedingly. It is very true, that the determination of the elevation of the waters in any place whatever is equally eaſy. The difficulty is, to exhibit for that place a connected view of the whole tide, with the hours of flood and ebb, and the difference between high and low water. This is not indeed difficult; but the proceſs by the ordinary rules of ſpherical trigonometry is tedious. When the ſun and moon are not near conjunction or oppoſition, the ſhape of the ocean reſembles a turnip, which is flat and not round in its broadeſt part. Before we can determine with preciſion the different phenomena in connection, we muſt aſcertain the poſition or attitude of this turnip; marking on the ſurface of the earth both its elliptical equators. One of theſe is the plane paſſing through the ſun and moon, and the other is perpendicular to it, and marks the place of low water. And we muſt mark in like manner its firſt meridian, which paſſes through all the four poles, and marks on the ſurface of the earth the place of high water. The poſition of the greateſt ſection of this compound ſpheroid is frequently much inclined to the earth's equator; nay ſometimes it is at right angles to it, when the moon has the ſame right aſcenſion with the ſun, but a different declination. In theſe caſes the ebb tide on the equator is the greateſt poſſible; for the lower poles of the compound ſpheroid are in the equator. Such ſituations occaſion a very complicated calculus. We muſt therefore content ourſelves with a good approximation.

And firſt, with reſpect to the times of high water. It will be ſufficient to conceive the ſun and moon as always in one plane, viz. the ecliptic. The orbits of the ſun and moon are never more inclined than $5\frac{1}{2}$ degrees. This will make very little difference; for when the luminaries are ſo ſituated that the great circle through them is much inclined to the equator, they are then very near to each other, and the form of the ſpheroid is little different from what it would be if they were really in conjunction or oppoſition. It will therefore be ſufficient to conſider the moon in three different ſituations.

1. In the equator. The point of higheſt water is never farther from the moon than 15°, when ſhe is in apogee, and the ſun in perigee. Therefore if a meridian be drawn through the point of higheſt water to the equator, the arch *mh* of fig. 4. will be repreſented on the equator by another arch about $\frac{92}{100}$ of this by reaſon of the inclination of the equator and ecliptic. Therefore, to have the time of high water, multiply the numbers of the columns which expreſs the difference of high water and the moon's ſouthing by $\frac{92}{100}$, and the products give the real difference.

2. Let the moon be in her greateſt declination. The arch of right aſcenſion correſponding to *mh* will be had by multiplying *mh*, or the time correſponding to it in the table, by $\frac{102}{92}$.

3. When the moon is in a middle ſituation between theſe two extremes, the numbers of the table will give the right aſcenſion correſponding to *mh* without any correction, the diſtance from the equator compenſating for the obliquity of the ecliptic arch *mh*.

The time of low water is not ſo eaſily found; and we muſt either go through the whole trigonometrical proceſs, or content ourſelves with a leſs perfect approximation. The trigonometrical proceſs is not indeed difficult: we muſt find the poſition of the plane through the ſun and moon. A great circle through the moon perpendicular to this is the line of high water; and another perpendicular circle cutting this at right angles is the circle of low water.

But it will be abundantly exact to conſider the tide as accompanying the moon only.

Fig. 7.

Let NQSE (fig. 7.) be a ſection of the terraqueous globe, of which N and S are the north and ſouth poles and EOQ the equator. Let the moon be in the direction OM, having the declination BQ. Let D be any place on the earth's ſurface. Draw the parallel LDC of latitude. Let B′F *b′f* be the ocean, formed into a ſpheroid, of which B*b* is the axis and *f*F the equator.

As the place D is carried along the parallel CDL by the rotation of the earth, it will paſs in ſucceſſion through different depths of the watery ſpheroid. It will have high water when at C and L, and low water when it croſſes the circle *f*OF. Draw the meridian N*d*G, and the great circle B*db*. The arch GQ, when converted into lunar hours (each about 62 minutes), gives the duration of the flood *dc* and of the ſubſequent ebb *cd*, which happen while the moon is above the horizon: and the arch EG will give the durations of the flood and of the ebb which happen when the moon is below the horizon. It is evident, that theſe two floods and two ebbs have unequal durations. When D is at C it has high water, and the height of the tide is CC′. For, the ſpheroid is ſuppoſed to touch the ſphere on the equator *f*OF, ſo that of CC′ is the difference between high and low water. At L the the height of the tide is LL′; and if we deſcribe the circle LN*q*, C*q* is the difference of theſe high waters, or of theſe tides.

Hence it appears, that the two tides of one lunar day may be conſiderably different, and it is proper to diſtinguiſh them by different names. We ſhall call that a *ſuperior tide* which happens when the moon is above the horizon during high water. The other may be called the *inferior tide*. The duration of the ſuperior tide is meaſured by 2GQ, and that of the inferior tide by 2EG; and 4GO meaſures the difference between the whole duration of a ſuperior and of an inferior tide.

From this conſtruction we may learn in general,
1. When the moon has no declination, the durations and alſo the heights of the ſuperior and inferior tides are equal in all parts of the world. For in this caſe the tide equator *f*F coincides with the meridian NOS, and the poles B′*b*′ of the watery ſpheroid are on the earth's equator.

2. When the moon has declination, the duration and alſo the height of a ſuperior tide at any place is greater than that of the inferior; or is leſs than it, according as the moon's declination and the latitude of the place are of the ſame or oppoſite names.

This is an important circumſtance. It frequently happens that the inferior tide is found the greateſt when it ſhould be the leaſt; which is particularly the caſe at the Nore. This ſhows, without further reaſoning, that the tide at the Nore is only a branch of the regular tide,

tide. The regular tide comes in between Scotland and the continent; and after travelling along the coaſt reaches the Thames, while the regular tide is juſt coming in again between Scotland and the continent.

3. If the moon's declination is equal to the colatitude of the place, or exceeds it, there will be only one tide in a lunar day. It will be a ſuperior or an inferior tide, according as the declination of the moon and the latitude of the place are of the ſame or oppoſite kinds. For the equator of the tide cuts the meridian in f and F. Therefore a place which moves in the parallel cf has high water when at c, and 12 lunar hours afterwards has low water when at f. And any place k which is ſtill nearer to the pole N has high water when at k, and 12 lunar hours afterwards has low water at m. Therefore, as the moon's declination extends to 30°, all places farther north or ſouth than the latitude 60° will ſometimes have only one tide in a lunar day.

4. The ſine of the arch GO, which meaſures $\frac{1}{4}$th of the difference between the duration of a ſuperior and inferior tide, is = tan. lat. × tan. decl. For in the ſpherical triangle dOG

Rad. : cotan. dOG = tan. dG : ſin. GO, and
Sin. GO = tan. dOQ × tan. dG, = tan. decl. × tan. lat.

Hence we ſee, that the difference of the durations of the ſuperior and inferior tides of the ſame day increaſe both with the moon's declination and with the latitude of the place.

The different ſituations of the moon and of the place of obſervation affect the heights of the tides no leſs remarkably. When the point D comes under the meridian NBQ in which the moon is ſituated, there is a ſuperior high water, and the height of the tide above the low water of that day is CC′. When D is at L, the height of the inferior tide is LL′. The elevation above the inſcribed ſphere is M × coſ.^{2}y, y being the zenith diſtance of the moon at the place of obſervation. Therefore at high water, which by the theory is in the place directly under the moon, the height of the tide is as the ſquare of the coſine of the moon's zenith or nadir diſtance.

Hence we derive a conſtruction which ſolves all queſtions relation to the height of the tides with great facility, free from all the intricacy and ambiguities of the algebraic analyſis employed by Bernoulli.

Fig. 8.

With the radius CQ = M (the elevation produced by the moon above the inſcribed ſphere) deſcribe the circle pQPE (fig. 8.) to repreſent a meridian, of which P and p are the poles, and EQ the equator. Biſect CP in O; and round O deſcribe the circle PBCD. Let M be the place over which the moon is vertical, and Z be the place of obſervation. MQ is the moon's declination, and ZQ is the latitude of the place. Draw MCm, ZCN, cutting the ſmall circle in A and B. Draw AGI perpendicular to CP, and draw CIμ, which will cut off an arch Eμ = QM. MZ and μN are the moon's zenith and nadir diſtances. Draw the diameter BD, and the perpendiculars IK, GH, and AF. Alſo draw OA, PA, AB, ID.

Then DF is the ſuperior tide, DK is the inferior tide, and DH is the arithmetical mean tide.

For the angles BCA, BDA, ſtanding on BA, are equal. Alſo the angles IDB, μCN, are equal, being ſupplements of the angle ICB. Therefore, if BD be made radius, DA and DI are the ſines of the zenith and nadir diſtances of the moon.

But BD : DA = DA : DF. Therefore DF = M × coſ.^{2}y, = the height Zz of the ſuperior tide. Alſo DK = M · coſ.$^{2}y'$, = the height $n\,n'$ of the inferior tide.

Alſo, becauſe IA is biſected in G, KF is biſected in H, and $\mathrm{DH} = \frac{\mathrm{DK}+\mathrm{DF}}{2}$, = the medium tide.

Let us trace the relation of the conſequences of the various poſitions of Z and M, as we formerly conſidered the reſults of the various ſituations of the ſun and moon.

Firſt, then, let Z retain its place, and let M gradually approach it from the equator. When M is in the equator, A and I coincide with C, and the three points F, K, and H, coincide in i.

As M approaches to Z, A and I approach to B and D; DF increaſes, and DK diminiſhes. The ſuperior or inferior tide is greateſt when the moon is in M or in N; and DF is then = M. As the moon paſſes to the northward of the place, the ſuperior and inferior tides both diminiſh till I comes to D; at which time MQ is equal to ZP, and there is no inferior tide. This however cannot happen if zP is greater than 30°, becauſe the moon never goes farther from the equator. M ſtill going north, we have again a perpendicular from I on BD, but below I, indicating that the inferior tide, now meaſured by DK, belongs to the hemiſpheroid next the moon. Alſo, as M advances from the equator northward, DH diminiſhes continually. Firſt, while H lies between O and B, becauſe G approaches O; and afterwards, when G is above O and H lies between O and D. It is otherwiſe, however, if ZQ is greater than $45''$; for then DB is inclined to EQ the other way, and DH increaſes as the point G riſes.

In the next place, let M retain its poſition, and Z proceed along the meridian.

Let us begin at the equator, or ſuppoſe Q the place of obſervation. BD then coincides with CP, and the three lines DF, DK, and DH, all coincide with PG, denoting the two equal tides Qq and Ee and their medium, equal to either. As Z goes northward from Q, BOD detaches itſelf from COP; the line DF increaſes, while DK and DH diminiſh. When Z has come to M, F and B coincide with A, and DK and DH are ſtill more diminiſhed. When Z paſſes M, all the three lines DF, DK, and DH, continue to diminiſh. When Z comes to latitudes 45°, DB is parallel to IA and EQ, and the point H coincides with O. This ſituation of Z has the peculiar property that DH (now DO) is the ſame, whatever be the declination of the moon. For IA being always parallel to DB, OK and OF will be equal, and DO will be half of DK and DF, however they may vary. When Z gets ſo far north that ZP is = MQ,. the diameter $b\,d$ falls on I; ſo that $d\,k$ vaniſhes, and we have only $d\!f$. And when Z goes ſtill farther north, $d\,k$ appears on the other ſide of I. When Z arrives at the pole, BD again coincides with PC, D with C, and DF, DK, and DH, coincide with CG.

Theſe variations of the points F, K, and H, indicate the following phenomena.

Fig. 1.

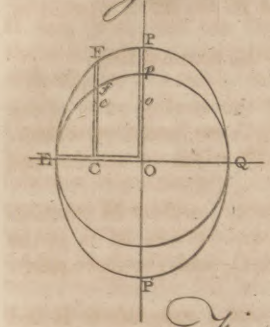


Fig. 2.

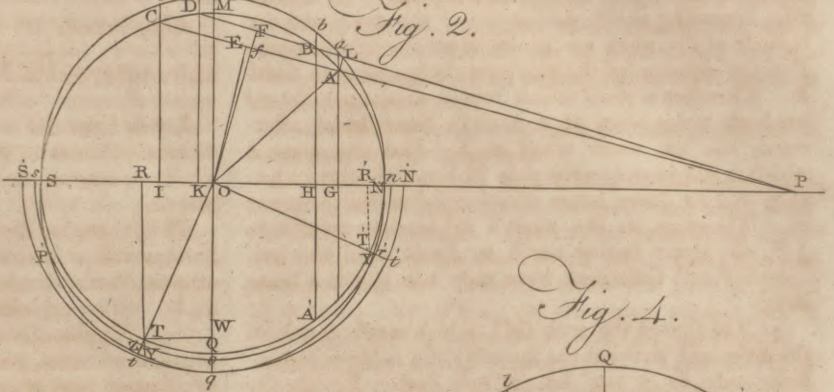


Fig. 3.

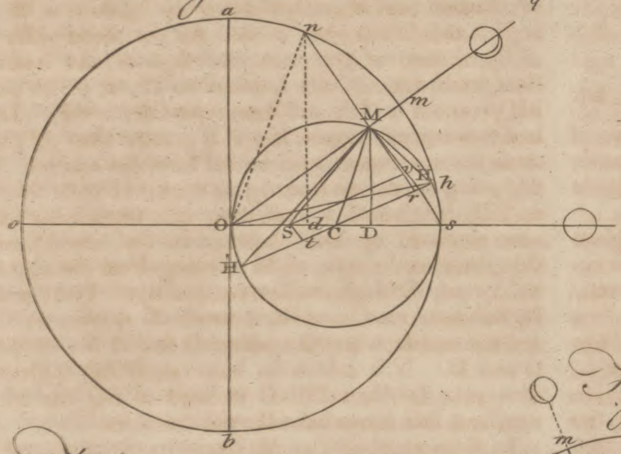


Fig. 4.

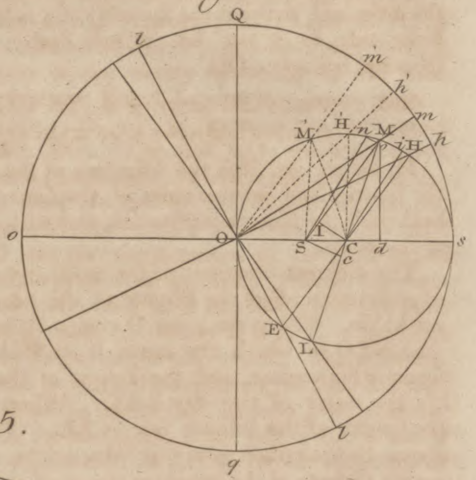


Fig. 5.

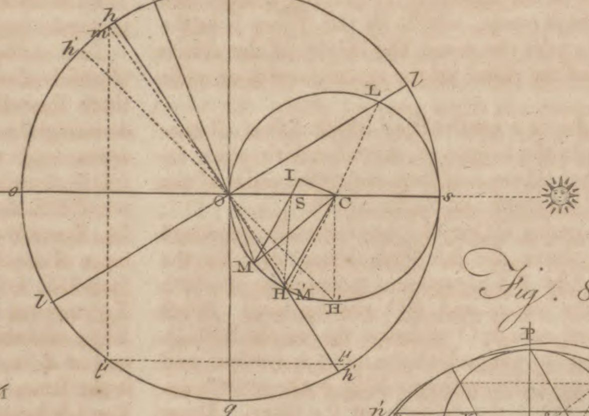


Fig. 6.

Fig. 7.

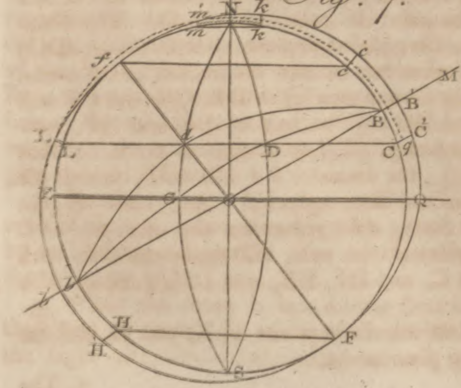
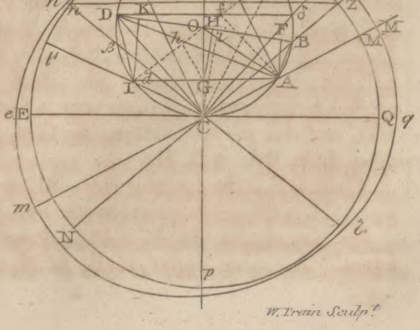


Fig. 8.



W. Train Sculp.t

1. The greateſt tides happen when the moon is in the zenith or nadir of the place of obſervation: for then the point B coincides with A, and DF becomes DB; that is, = M, indicating the full tide BB′.

2. When the moon is in the equator, the ſuperior and inferior tides have equal heights, = M · coſ.^{2} lat. For then A and I coincide with C, and the points F and K coincide in *i*, and D*i* is = DB · coſ.^{2} BDC, = M · coſ.^{2} lat.

3. If the place of obſervation is in the equator, the inferior and ſuperior tides are again equal, whatever is the moon's declination: For then B coincides with C, and the points F, K, and H, coincide with G; and PG × PC · coſ.^{2} APG, = M · coſ.^{2} decl. moon.

4. The ſuperior tides are greater or leſs than the inferior tides according as the latitude and declination are of the ſame or of oppoſite names. For by making Qζ = QZ, and drawing ζ C *n*, cutting the ſmall circle in β, we ſee that the figure is reverſed. The difference between the ſuperior and inferior tides is KF, or IA × coſin. of the angle formed by IA and DB; that is, of the angle BDδ, which is the complement of twice ZQ; becauſe BOC = 2 ZCQ. Now IA is 2 GA, = 2 OA · ſin. 2 MQ = PC · ſin. 2 MQ, = M · ſin. 2 decl. Therefore the difference of the ſuperior and inferior tides is M · ſin. 2 declin. ſin. 2 lat.

5. If the colatitude be equal to the declination, or leſs than it, there will be no inferior tide, or no ſuperior tide, according as the latitude of the place and declination of the moon are of the ſame or oppoſite names.

For when PZ = MQ, D coincides with I, and IK vaniſhes. When PZ is leſs than MQ, the point D is between C and I, and the point Z never paſſes through the equator of the watery ſpheroid; and the low water of its only tide is really the ſummit of the inferior tide.

6. At the pole there is no daily tide: but there are two monthly tides = M · ſin.^{2} declin. and it is low water when the moon is in the equator.

7. The medium tide, repreſented by DH, is = M × $\frac{1 + \text{coſ. 2 lat.} \times \text{coſ. 2 declin.}}{2}$. For DH = DO + OH. Now OH is equal to OG × coſ. GOH = OG · coſ. 2ZQ. And OG = OA · coſ. GOA, = OA · coſ. 2MQ. Therefore OH = OA · coſ. 2ZQ · coſ. 2MQ. Therefore DH = OA + OA · coſ. 2ZQ · coſ. 2MQ = M × $\frac{1 + \text{coſ. 2ZQ} \cdot \text{coſ. 2 MQ}}{2}$. Let this for the future be called *m*.

N. B. The moon's declination never exceeds 30°. Therefore coſ. 2 MQ is always a poſitive quantity, and never leſs than $\frac{1}{2}$, which is the coſine of 60°. While the latitude is leſs than 45°, coſ. 2 lat. is alſo a poſitive quantity. When it is preciſely 45° the coſine of its double is *o*; and when it is greater than 45, the coſine of its double is negative. Hence we ſee,

1. That the medium tides are equally affected by the northern and ſouthern declinations of the moon.

2. If the latitude of the place is 45°, the medium tide is always $\frac{1}{2}$ M. This is the reaſon why the tides along the coaſts of France and Spain are ſo little affected by the declination of the moon.

3. If the latitude is leſs than 45°, the mean tides increaſe as the moon's declination diminiſhes. The contrary happens if ZQ is greater than 45°. For DH increaſes or diminiſhes while the point G ſeparates from C according as the angle COD is greater or leſs than COB; that is, according as PCZ is greater or leſs than ZCQ.

4. When Z is in the equator, H coincides with G, and the effect of the moon's declination on the height of the tides is the moſt ſenſible. The mean tide is then = M $\frac{1 + \text{coſ. 2 MQ}}{2}$.

All that we have now ſaid may be ſaid of the ſolar tide, putting S in place of M.

Alſo the ſame things hold true of ſpring tides putting M + S in place of M.

But in order to aſcertain the effects of declination and latitude on other tides, we muſt make a much more complicated conſtruction, even though we ſuppoſe both luminaries in the ecliptic. For in this caſe the two depreſſed poles of the watery ſpheroid are not in the poles of the earth; and therefore the ſections of the ocean, made by meridians, are by no means ellipſes.

Fig. 7. or 8.

In a neap tide, the moon is vertical at B (fig. 7. or 8.), and the ſun at ſome point of *f* F, 90° from B. If O be this point, the conſtruction for the heights of the tides may be made by adding to both the ſuperior and inferior tides for any point D, the quantity $\overline{\text{M} + \text{S} - \text{D′F or DK}}$ × ſin.^{2} *d* O, = $\overline{\text{M} + \text{S} - \text{tide}}$ × $\frac{\text{ſin.}^2\ 2\ \text{Q}}{\text{coſ.}^2\ \text{MQ}}$, as is evident.

But if the ſun be vertical at *d*, *d* will be the higheſt part of the circle *f* OF, and no correction is neceſſary. But in this caſe the circle of high water will be inclined to the meridian in an angle equal to *d* BO (fig. 7.), and neither the times nor elevations of high water will be properly aſcertained, and the error in time may be conſiderable in high latitudes.

The inaccuracies are not ſo great in intermediate tides, and reſpect chiefly the time of high water and the height of low water.

The exact computation is very tedious and peculiar, ſo that it is hardly poſſible to give any account of a regular progreſs of phenomena; and all we can do is, to aſcertain the preciſe heights of detached points. For which reaſons, we muſt content ourſelves with the conſtruction already given. It is the exact geometrical expreſſion of Bernoulli's analyſis, and its conſequences now related contain all that he has inveſtigated. We may accommodate it very nearly to the real ſtate of things, by ſuppoſing PC equal, not to CO of fig. 4. but to MS, exhibiting the whole compound tide. And the point B, inſtead of repreſenting the moon's place, muſt repreſent the place of high water.

Thus have we obtained a general, though not very accurate, view of the phenomena which muſt take place in different latitudes and in different declinations of the ſun and moon, provided that the phyſical theory which determines the form and poſition of the watery ſpheroid be juſt. We have only to compute, by a very ſimple proceſs of ſpherical trigonometry, the place of the pole of this ſpheroid. The ſecond conſtruction, in fig. 8. ſhows us all the circumſtances of the time and height of high water at any point. It will be recollected, that in computing this place of the pole, the anticipation of 20 degrees, ariſing from the inertia of the waters, muſt be attended to.

Were we to inſtitute a compariſon of this theory with obſervation, without farther conſideration, we ſhould ſtill find it unfavourable, partly in reſpect of the heights of the tides, and more remarkably in reſpect of the time of low water. We muſt again conſider the effects of the inertia of the waters, and recollect, that a regular theoretical tide differs very little in its progreſs from the motion of a wave. Even along the free ocean, its motion much reſembles that of any other wave. All waves are propagated by an oſcillatory motion of the waters, preciſely ſimilar to that of a pendulum. It is well known, that if a pendulum receive a ſmall impulſe in the time of every deſcent, its vibrations may be increaſed to infinity. Did the ſucceſſive actions of the ſun or moon juſt keep time with the natural propagation of the tides, or the natural oſcillations of the waters, the tides would alſo augment to infinity: But there is an infinite odds againſt this exact adjuſtment. It is much more probable that the action of to-day interrupts or checks the oſcillation produced by yeſterday's action, and that the motion which we perceive in this day's tide is what remains, and is compounded with the action of to-day. This being the caſe, we ſhould expect that the nature of any tide will depend much on the nature of the preceding tide. Therefore we ſhould expect that the ſuperior and inferior tides of the ſame day will be more nearly equal than the theory determines. The whole courſe of obſervation confirms this. In latitude 45°, the ſuperior and inferior tides of one day may differ in the proportion of $2\frac{1}{2}$ to 1, and the tides correſponding to the greateſt and leaſt declinations of the moon may differ nearly as much. But the difference of the ſuperior and inferior tides, as they occur in the liſt of Obſervations at Rochefort, is not the third part of this, and the changes made by the moon's declination is not above one-half. Therefore we ſhall come much nearer the true meaſure of a ſpring tide, by taking the arithmetical mean, than by taking either the ſuperior or inferior.

We ſhould expect leſs deviation from the theory in the gradual diminution of the tides from ſpring tide to neap tide, and in the gradual changes of the medium tide by the declination of the moon; becauſe the ſucceſſive changes are very ſmall; and when they change in kind, that is, diminiſh after having for ſome time augmented, the change is by inſenſible degrees. This is moſt accurately confirmed by obſervation. The vaſt collection made by Caſſini of the Obſervations at Breſt being examined by Bernoulli, and the medium of the two tides in one day being taken for the tide of that day, he found ſuch an agreement between the progreſſion of theſe medium tides and the progreſſion of the lines MS of fig. 4. that the one ſeemed to be calculated by the other. He found no leſs agreement in the changes of the medium tides by the moon's declination.

In like manner, the changes produced by the different diſtances of the moon from the earth, were found abundantly conformable to the theory, although not ſo exact as the other. This difference or inferiority is eaſily accounted for: When the moon changes in her mean diſtance, one of the neap tides is uncommonly ſmall, and therefore the ſucceſſive diminutions are very great, and one tide ſenſibly affects another. The ſame circumſtance operates when ſhe changes in apogee, by reaſon of a very large ſpring tide. And the changes correſponding both to the ſun's diſtance from the earth and his declination agreed almoſt exactly.

All theſe things conſidered together, we have abundant reaſon to conclude, that not only the theory itſelf is juſt in principle (a thing which no intelligent naturaliſt can doubt), but alſo that the data which are aſſumed in the application are properly choſen; that is, that the proportion of two to five is very nearly the true proportion of the mean ſolar and lunar forces. If we now compute the medium tide for any place in ſucceſſion, from ſpring tide to neap tide, and ſtill more, if we compute the ſeries of times of their occurrence, we ſhall find as great an agreement as can be deſired. Not but that there are many irregularities; but theſe are evidently ſo anomalous, that we can aſcribe them to nothing but circumſtances which are purely local.

This general rule of computation muſt be formed in the following manner:

The ſpring tide, according to theory, being called A, and the neap tide B, recollect that the ſpring tide, according to the regular theory, is meaſured by $\text{M}+\text{S}$. Recollect alſo, that when the lunar tide only is conſidered the ſuperior ſpring tide is $\text{M}\times\text{ſin.}^2$, ZM (fig. 8.). But when we conſider the action of two adjoining tides on each other, we find it ſafer to take the medium of the ſuperior and inferior tides for the meaſure; and this is $\text{M}\times\frac{1+\text{coſ.}^2\ 2\,\text{ZQ}\times\text{coſ.}\ 2\,\text{MQ}}{2}$. Let this be called *m*. This being totally the effect of M as modified by latitude and declination, may be taken as its proper meaſure, by which we are to calculate the other tides of the monthly ſeries from ſpring tide to neap tide.

In like manner, we muſt compute a value for S, as modified by declination and latitude; call this *s*. Then ſay,

$$\text{M}+\text{S} : \text{A} = m+s : \text{A}\times\frac{m+s}{\text{M}+\text{S}}.$$

This fourth proportional will give the ſpring tide as modified for the given declination of the luminaries, and the latitude of the place.

Now recollect, that the medium tide, when the luminaries are in the equator, is $\text{A}\times\text{coſ.}^2$ lat. Therefore let F be the ſpring tide *obſerved* at any place when the luminaries are in the equator; and let this be the medium of a great many obſervations made in theſe circumſtances. This gives $\text{A}\cdot\text{coſ.}^2$ lat. (as modified by the peculiar circumſtances of the place) $=$ F. Therefore the fourth proportional now given changes to $\text{F}\times\frac{m+s}{\overline{\text{M}+\text{S}}\cdot\text{coſ.}^2\ \text{lat.}}$. And a ſimilar ſubſtitute for B is $\text{G}\times\frac{m-s}{\overline{\text{M}-\text{S}}\cdot\text{coſ.}^2\ \text{lat.}}$.

Laſtly, To accommodate our formulæ to every diſtance of the earth from the ſun and moon, let D and Δ be the mean diſtances of the ſun and moon, and *d* and ∂ their diſtances at the given time; and then the two ſubſtitutes become

$$\frac{\Delta^3 d^3\,\text{M}+\partial^3\text{D}^3\,\text{S}}{d^3\partial^3\,(\text{M}+\text{S})}\times\text{F}\times\frac{m+s}{(\text{M}+\text{S})\text{coſ.}^2\ \text{lat.}}.$$

$$\frac{\Delta^3 d^3\,\text{M}-\partial^3\text{D}^3\,\text{S}}{d^3\partial^3\,(\text{M}-\text{S})}\times\text{G}\times\frac{m+s}{(\text{M}-\text{S})\ \text{coſ.}^2\ \text{lat.}}.$$

The

The half ſum of theſe two quantities will be the MC, and their half difference will be the SC, of fig. 4. with which we may now operate, in order to find the tide for any other day of the menſtrual ſeries, by means of the elongation a of the moon from the ſun; that is, we muſt ſay $MC+CS : MC-CS=$ tan. a : tan. b; then $x=\frac{a+b}{2}$, and $y=\frac{a-b}{2}$. And MS, the height of the tide, is $MC\times$ coſ. $2y+CS\times$ coſ. $2x$.

SUCH is the general theory of the tides, deduced from the principle of univerſal gravitation, and adjuſted to that proportion of the ſolar and lunar forces which is moſt conſiſtent with other celeſtial phenomena. The compariſon of the greateſt and leaſt daily retardations of the tides was with great judgement preferred to the proportion of ſpring and neap tides, ſelected by Sir Iſaac Newton for this purpoſe. This proportion muſt depend on many local circumſtances. When a wave or tide comes to the mouths of two rivers, and ſends a tide up each, and another tide of half the magnitude comes a fortnight after; the proportion of tides ſent up to any given places of theſe rivers may be extremely different. Nay, the proportion of tides ſent up to two diſtant places of the ſame river can hardly be the ſame; nor are they the ſame in any river that we know. It can be demonſtrated, in the ſtricteſt manner, that the farther we go up the river, where the declivity is greater, the neap tide will be ſmaller in proportion to the ſpring tide. But it does not appear that the time of ſucceſſion of the different tides will be much affected by local circumſtances. The tide of the ſecond day of the moon being very little leſs than that of the firſt, will be nearly as much retarded, and the intervals between their arrivals cannot be very different from the real intervals of the undiſturbed tides; accordingly, the ſucceſſion of the higheſt to the higheſt but one is found to be the ſame in all places, when not diſturbed by *different* winds. In like manner, the ſucceſſion of the loweſt and the loweſt but one is found equally invariable; and the higheſt and the loweſt tides obſerved in any place *muſt* be accounted the ſpring and neap tides of that place, whether they happen on the day of full and half moon or not. Nay, we can ſee here the explanation of a general deviation of the theory which we formerly noticed. A low tide, being leſs able to overcome obſtructions, will be ſooner ſtopped, and the neap tides ſhould happen a little earlier than by the undiſturbed theory.

With all theſe corrections, the theory now delivered will be found to correſpond with obſervation, with all the exactneſs that we can reaſonably expect. We had an opportunity of comparing it with the phenomena in a place where they are very ſingular, viz. in the harbour of Biſſeſtedt in Iceland. The equator of the watery ſpheroid frequently paſſes through the neighbourhood of this place, in a variety of poſitions with reſpect to its parallel of diurnal revolution, and the differences of ſuperior and inferior tides are moſt remarkable and various. We found a wonderful conformity to the moſt diverſified circumſtances of the theory.

There is a period of 18 years, reſpecting the tides in Iceland, taken notice of by the ancient Saxons; but it is not diſtinctly deſcribed. Now this is the period of the moon's nodes, and of the greateſt and leaſt inclination of her orbit to the equator. It is therefore the period of the poſitions of the equator of the tides which ranges round this iſland, and very ſenſibly affects them.

Hitherto we have ſuppoſed the tides to be formed on an ocean completely covering the earth. Let us ſee how thoſe may be determined which happen in a ſmall and confined ſea, ſuch as the Caſpian or the Black ſea. The determination in this caſe is very ſimple. As no ſupply of water is ſuppoſed to come into the baſon, it is ſuſceptible of a tide only by ſinking at one end and riſing at the other. This may be illuſtrated by fig. 6. where C s, C y, are two perpendicular planes bounding a ſmall portion of the natural ocean. The water will ſink at z and riſe at x, and form a ſurface $o\,t\,r$ parallel to the equilibrated ſurface $y\,s$. It is evident that there will be high water, or the greateſt poſſible riſe, at r, when the baſon comes to that poſition where the tangent is moſt of all inclined to the diameter. This will be when the angle t CB is 45° nearly, and therefore three lunar hours after the moon's ſouthing; at the ſame time, it will be low water at the other end. It is plain that the riſe and fall muſt be exceedingly ſmall, and that there will be no change in the middle. The tides of this kind in the Caſpian ſea, in latitude 45°, whoſe extent in longitude does not exceed eight degrees, are not above ſeven inches; a quantity ſo ſmall, that a ſlight breeze of wind is ſufficient to check it, and even to produce a riſe of the waters in the oppoſite direction. We have not met with any accounts of a tide being obſerved in this ſea.

It ſhould be much greater, though ſtill very ſmall, in the Mediterranean ſea. Accordingly, tides are obſerved there, but ſtill more remarkably in the Adriatic, for a reaſon which will be given by and by. We do not know that tides have been obſerved in the great lakes of North America. Theſe tides, though ſmall, ſhould be very regular.

Should there be another great baſon in the neighbourhood of $z\,x$, lying eaſt or weſt of it, we ſhould obſerve a curious phenomenon. It would be low water on one ſide of the ſhore z when it is high water on the other ſide of this partition. If the tides in the Euxine and Caſpian ſeas, or in the American lakes which are near each other, could be obſerved, this phenomenon ſhould appear, and would be one of the pretticſt examples of univerſal gravitation that can be conceived. Something like it is to be ſeen at Gibraltar. It is high water on the eaſt ſide of the rock about 10 o'clock at full and change, and it is high water on the weſt ſide, not a mile diſtant, at 12. This difference is perhaps the chief cauſe of the ſingular current which is obſerved in the Straits mouth. There are three currents obſerved at the ſame time, which change their directions every 12 hours. The ſmall tide of the Mediterranean proceeds along the Barbary ſhore, which is very uniform all the way from Egypt, with tolerable regularity. But along the northern ſide, where it is greatly obſtructed by Italy, the iſlands, and the eaſt coaſt of Spain, it ſets very irregularly; and the perceptible high water on the Spaniſh coaſt differs four hours from that of the ſouthern coaſt. Thus it happens, that one tide ranges round Europa point, and another along the ſhore near Ceuta, and there is a third current in the middle different from both. Its general direction is from the

Atlantic ocean into the Mediterranean ſea, but it ſometimes comes out when the ebb tide in the Atlantic is conſiderable.

Suppoſe the moon over the middle of the Mediterranean. The ſurface of the ſea will be level, and it will be half tide at both ends, and therefore within the Straits of Gibraltar. But without the Straits it is within half an hour of high water. Therefore there will be a current ſetting *in* from the Atlantic. About three and an half hours after, it is high water within and half ebb without. The current now ſets out from the Mediterranean. Three hours later, it is low water without the Straits and half ebb within; therefore the current has been ſetting out all this while. Three hours later, it is half flood without the Straits and low water within, and the current is again ſetting in, &c.

Were the earth fluid to the centre, the only ſenſible motion of the waters would be up and down, like the waves on the open ocean, which are not bruſhed along by ſtrong gales. But the ſhallowneſs of the channel makes a horizontal motion neceſſary, that water may be ſupplied to form the accumulation of the tide. When this is formed on a flat ſhelving coaſt, the water muſt flow in and out, on the flats and ſands, while it riſes and falls. Theſe horizontal motions muſt be greatly modified by the channel or bed along which they move. When the channel contracts along the line of flowing water, the wave, as it moves up the channel, and is checked by the narrowing ſhores, muſt be reflected back, and keep a-top of the waters ſtill flowing in underneath. Thus it may riſe higher in theſe narrow ſeas than in the open ocean. This may ſerve to explain a little the great tides which happen on ſome coaſts, ſuch as the coaſt of Normandy. At St Malo the flood frequently riſes 50 feet. But we cannot give any thing like a full or ſatisfactory account of theſe ſingularities. In the bay of Fundy, and particularly at Annapolis Royal, the water ſometimes riſes above 100 feet. This ſeems quite inexplicable by any force of the ſun and moon, which cannot raiſe the waters of the free ocean more than eight feet. Theſe great floods are unqueſtionably owing to the proper timing of certain oſcillations or currents adjoining, by which they unite, and form one of great force. Such violent motions of water are frequently ſeen on a ſmall ſcale in the motions of brooks and rivers; but we are too little acquainted with hydraulics to explain them with any preciſion.

We have ſeen that there is an oſcillation of waters formed under the ſun and moon; and that in conſequence of the rotation of the earth, the inertia and the want of perfect fluidity of the waters, and obſtructions in the channel, this accumulation never reaches the place where it would finally ſettle if the earth did not turn round its axis. The conſequence of this muſt be a general current of the waters from eaſt to weſt. This may be ſeen in another way. The moon in her orbit round the earth has her gravity to the earth diminiſhed by the ſun's diſturbing force, and therefore moves in an orbit leſs incurvated than ſhe would deſcribe independent of the ſun's action. She therefore employs a longer time. If the moon were ſo near the earth as almoſt to touch it, the ſame thing would happen. Therefore ſuppoſe the moon turning round the earth, almoſt in contact with the equator, with her natural undiſturbed periodic time, and that the earth is revolving round its axis in the ſame time, the moon would remain continually above the ſame ſpot of the earth's ſurface (ſuppoſe the city of Quito), and a ſpectator in another planet would ſee the moon always covering the ſame ſpot. Now let the ſun act. This will not affect the rotation of the earth, becauſe the action on one part is exactly balanced by the action on another. But it will affect the moon. It will move more ſlowly round the earth's centre, and at a greater diſtance. It will be left behind by the city of Quito, which it formerly covered. And as the earth moves round from weſt to eaſt, the moon, moving more ſlowly, will have a motion to the weſt with reſpect to Quito. In like manner, every particle of water has its gravity diminiſhed, and its diurnal motion retarded; and hence ariſes a general motion or current from eaſt to weſt. This is very diſtinctly perceived in the Atlantic and Pacific oceans. It comes round the Cape of Good Hope, ranges along the coaſt of Africa, and then ſets directly over to America, where it meets a ſimilar ſtream which comes in by the north of Europe. Meeting the ſhores of America, it is deflected both to the ſouth along the coaſt of Brazil, and to the north along the North American ſhores, where it forms what is called the *Gulf Stream*, becauſe it comes from the gulf of Mexico. This motion is indeed very ſlow, this being ſufficient for the accumulation of ſeven or eight feet on the deep ocean; but it is not altogether inſenſible.

We may expect differences in the appearances on the weſtern ſhores of Europe and Africa, and on the weſtern ſhore of America, from the appearances on the eaſtern coaſts of America and of Aſia, for the general current obſtructs the waters from the weſtern ſhores, and ſends them to the eaſtern ſhores. Alſo when we compare the wide opening of the northern extremity of the Atlantic ocean with the narrow opening between Kamtſchatka and America, we ſhould expect differences between the appearances on the weſt coaſts of Europe and of America. The obſervations made during the circumnavigations of Captain Cook and others ſhow a remarkable difference. All along the weſt coaſt of North America the inferior tide is very trifling, and frequently is not perceived.

In the very ſame manner, the diſturbing forces of the ſun and moon form a tide in the fluid air which ſurrounds this globe, conſiſting of an elevation and depreſſion, which move gradually from eaſt to weſt. Neither does this tide ever attain that poſition with reſpect to the diſturbing planets which it would do were the earth at reſt on its axis. Hence ariſes a motion of the whole air from eaſt to weſt; and this is the principal cauſe of the trade-winds. They are a little accelerated by being heated, and therefore expanding. They expand more to the weſtward than in the oppoſite direction, becauſe the air expands on that ſide into air which is now cooling and contracting. Theſe winds very evidently follow the ſun's motion, tending more to the ſouth or north as he goes ſouth or north. Were this motion conſiderably affected by the expanſion of heated air, we ſhould find the air rather coming northward and ſouthward from the torrid zone, in conſequence of its expanſion in that climate. We repeat it, it is almoſt ſolely produced by the aerial tide, and is neceſſary for the very formation of this tide. We cannot perceive the accumulation. It cannot affect the barometer, as

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many think, becauſe, though the air becomes deeper, it becomes deeper only becauſe it is made lighter by the gravitation to the ſun. Inſtead of preſſing more on the ciſtern of the barometer, we imagine that it preſſes leſs; becauſe, like the ocean, it never attains the height to which it tends. It remains always too low for equilibrium, and therefore it ſhould preſs with leſs force on the ciſtern of a barometer.

There is an appearance preciſely ſimilar to this in the planet Jupiter. He is ſurrounded by an atmoſphere which is arranged in zones or belts, probably owing to climate differences of the different latitudes, by which each ſeems to have a different kind of ſky. Something like this will appear to a ſpectator in the moon looking at this earth. The general weather and appearance of the ſky is conſiderably different in the torrid and temperate zones. Jupiter's belts are not of a conſtant ſhape and colour; but there often appear large ſpots or tracts of cloud, which retain their ſhape during ſeveral revolutions of Jupiter round his axis. To judge of his rotation by one of theſe, we ſhould ſay that he turns round in 9.55. There is alſo a brighter ſpot which is frequently ſeen, occupying one certain ſituation on the body of Jupiter. This is ſurely adherent to his body, and is either a bright coloured country, or perhaps a tract of clouds hovering over ſome volcano. This ſpot turns round in $9.51\frac{1}{4}$. And thus there is a general current in his atmoſphere from eaſt to weſt.

Both the motion of the air and of the water tend to diminiſh the rotation of the earth round its axis; for they move ſlower than the earth, becauſe they are retarded by the luminaries. They muſt communicate this retardation to the earth, and muſt take from it a quantity of motion preciſely equal to what they want, in order to make up the equilibrated tide. In all probability this retardation is compenſated by other cauſes; for no retardation can be obſerved. This would have altered the length of the year ſince the time of Hipparchus, giving it a ſmaller number of days. We ſee cauſes of compenſation. The continual waſhing down of ſoil from the elevated parts of the earth muſt produce this effect, by communicating to the valley on which it is brought to reſt the exceſs of diurnal velocity which it had on the mountain top.

While we were employed on this article, a book was put into our hands called *Studies of Nature*, by a Mr Saint Pierre. This author ſcouts the Newtonian theory of the tides, as erroneous in principle, and as quite inſufficient for explaining the phenomena; and he aſcribes all phenomena of the tides to the liquefaction of the ices and ſnows of the circumpolar regions, and the greater length of the polar than of the equatorial axis of the earth. He is a man of whom we wiſh to ſpeak with reſpect, for his conſtant attention to final cauſes, and the proof thence reſulting of the wiſdom and goodneſs of God. For this he is entitled to the greater praiſe, that it required no ſmall degree of fortitude to reſiſt the influence of national example, and to retain his piety in the midſt of a people who have drunk the very dregs of the atheiſm of ancient Greece. This is a ſpecies of merit rarely to be met with in a Frenchman of the preſent day; but as a philoſopher, M. de St Pierre can lay claim to no other merit except that of having collected many important facts. The argument which he employs to prove that the earth is a prolate ſpheroid, is a direct demonſtration of the truth of the contrary opinion; and the melting of the ice and ſnows at the poles cannot produce the ſmalleſt motion in the waters. Were there even ten times more ice and ſnow floating on the northern ſea than there is, and were it all to melt in one minute, there would be no flux from it; for it would only fill up the ſpace which it formerly occupied in the water. Of this any perſon will be convinced, who ſhall put a handful of ſnow ſqueezed hard into a jar of water, and note the exact height of the water. Let the ſnow melt, and he will find the water of the ſame height as before.

TIDE-Waiters, or *Tideſmen*, are inferior officers belonging to the cuſtomhouſe, whoſe employment is to watch or attend upon ſhips until the cuſtoms be paid: they get this name from their going on board ſhips on their arrival in the mouth of the Thames or other ports, and ſo come up with the tide.

TIEND, in *Scots Law*. See TEIND.

TIERCE, or TEIRCE, a meaſure of liquid things, as wine, oil, &c. containing the third part of a pipe, or 42 gallons.

TIERCED, in *Heraldry*, denotes the ſhield to be divided by any part of the partition-lines, as party, coupy, tranchy, or tailly, into three equal parts of different colours or metals.

TIGER. See FELIS, MAMMALIA *Index*.

TIGER-Wolf, the name of the hyæna at the Cape of Good Hope. See CANIS, MAMMALIA *Index*.

TIGRIS, a river of Aſia, which has its ſource near that of the Euphrates in the mountain Tchildir in Turkomania: afterwards it ſeparates Diarbeck from Erzerum, and Khuſiſtan from Irac-Arabia; and uniting with the Euphrates at Gorno, it falls into the gulf of Baſſorah, under the name of *Schat el-Arab*. This river paſſes by Diarbekir, Gezira, Mouſul, Bagdad, Gorno, and Baſſorah.

TILIA, LIME or LINDEN-TREE, a genus of plants belonging to the claſs of polyandria; and in the natural ſyſtem ranging under the *Columniferæ*. See BOTANY *Index*.

TILLEMONT, SEBASTIAN LE NAIN DE. See NAIN.

TILLER *of a SHIP*, a ſtrong piece of wood faſtened in the head of the rudder, and in ſmall ſhips and boats called the *helm*.

TILLOEA, a genus of plants belonging to the claſs of tetrandria; and in the natural ſyſtem ranging under the 13th order, *Succulentæ*. See BOTANY *Index*.

TILLOTSON, JOHN, a celebrated archbiſhop of Canterbury, was the ſon of Robert Tillotſon of Sowerby, in the pariſh of Halifax in Yorkſhire, clothier; and was born there in the year 1630. He ſtudied in Clare-hall, Cambridge; and in 1656 left this college, in order to become tutor to the ſon of Edmund Prideaux, Eſq. of Ford abbey in Devonſhire. He was afterwards curate to Dr Hacket vicar of Cheſhunt, in Hertfordſhire. In 1663, he was preſented by Sir Thomas Barnardiſton to the rectory of Ketton or Keddington in the county of Suffolk; but was the next year choſen preacher to Lincoln's Inn, when he procured Ketton to be beſtowed on his curate. He was greatly admired in London for his ſermons; and in the ſame year was choſen Tueſday-lecturer at St Lawrence's church, London, where his lectures were frequented by all the divines of the city, and by many perſons of quality and diſtinction. In 1666, he took the degree of Doctor of Divinity at Cambridge; in 1669, was made prebendary of Canterbury; in 1672, was admitted dean of that cathedral; and three years after, was made a prebendary of St Paul's cathedral, London. In 1679, he became acquainted with Charles earl of Shrewſbury, whom he converted from Popery; and the next year refuſed to ſign the clergy of London's addreſs of thanks to King Charles II. for not agreeing to the bill of excluſion of the duke of York. In 1683, he viſited the unfortunate Lord Ruſſel when under condemnation; and attended him in his laſt moments on the ſcaffold. In 1689, he was inſtalled dean of St Paul's; made clerk of the cloſet to King William and Queen Mary; and appointed one of the commiſſioners to prepare matters to be laid before the convocation, in order to a comprehenſion of all Proteſtants, as well diſſenters as churchmen; but this attempt was fruſtrated by the zeal of thoſe members of that body, who refuſed to admit of any alteration in things confeſſedly indifferent. In 1691, Dr Tillotſon was, notwithſtanding the warmeſt remonſtrances and intreaties on his part, conſecrated archbiſhop of Canterbury, and four days after was ſworn one of the privy council; their majeſties always repoſing an entire confidence in his prudence, moderation, and integrity. In 1694, he was ſeized with a palſy, of which he died in the 65th year of his age. He was interred in the church of St Lawrence Jewry, London, where a handſome monument is erected to his memory. This learned and pious divine, while living, was greatly inveighed againſt by the enemies of the revolution. After his death there was found a bundle of bitter libels which had been publiſhed againſt him, on which he had written with his own hand, "I forgive the authors of theſe books, and pray God that he may alſo forgive them." It is remarkable, that while this truly great man was in a private ſtation, he always laid aſide two-tenths of his income for charitable uſes. One volume in folio of Dr Tillotſon's ſermons was publiſhed in his life-time, and corrected by his own hand; they were tranſlated into French by Barbeyrac. Thoſe which came abroad after his death, from his chaplain Dr Barker, made two volumes in folio, the copy of which was ſold for 2500l. This was the only legacy he left to his family, his extenſive charity having conſumed his yearly revenues as conſtantly as they came to his hands. King William, however, gave two grants to his widow; the firſt of which was an annuity of 400l. during the term of her natural life, and the ſecond of 200l. as an addition to the former annuity. Dr Tillotſon wrote ſome other works beſides his Sermons; and alſo publiſhed Dr Barrow's works, and Dr Wilkins's Treatiſe of the Principles and Duties of Natural Religion, and a volume of that divine's Sermons.

TIMBER, wood fit for building, &c. See TREE, and *STRENGTH of Materials*.

TIMBERS, the ribs of a ſhip, or the incurvated pieces of wood, branching outward from the keel in a vertical direction, ſo as to give ſtrength, figure, and ſolidity, to the whole fabric. See SHIP-BUILDING, book i. chap. ii.

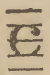
TIME, a ſucceſſion of phenomena in the univerſe, or a mode of duration marked by certain periods or meaſures, chiefly by the motion and revolution of the ſun.

The general idea which time gives in every thing to which it is applied, is that of limited duration. Thus we cannot ſay of the Deity, that he exiſts in time; becauſe eternity, which he inhabits, is abſolutely uniform, neither admitting limitation nor ſucceſſion. See METAPHYSICS, N° 209.

TIME, in *Muſic*, is an affection of ſound, by which it is ſaid to be long or ſhort, with regard to its continuance in the ſame tone or degree of tune.

Muſical time is diſtinguiſhed into *common* or *duple* time, and *triple* time.

Double, *duple*, or *common* time, is when the notes are in a duple duration of each other, viz. a ſemibreve equal to two minims, a minim to two crotchets, a crotchet to two quavers, &c.

Common or double time is of two kinds. The firſt when every bar or meaſure is equal to a ſemibreve, or its value in any combination of notes of a leſs quantity. The ſecond is where every bar is equal to a minim, or its value in leſs notes. The movements of this kind of meaſure are various, but there are three common diſtinctions; the firſt *ſlow*, denoted at the beginning of the line by the mark C; the ſecond *briſk*, marked thus ; and the third *very briſk*, thus marked .

Triple time is when the durations of the notes are triple of each other, that is, when the ſemibreve is equal to three minims, the minim to three crotchets, &c. and it is marked T.

TIME-Keepers, or *Inſtruments for meaſuring Time.* See CLOCK, DIAL, WATCH, &c.

Harriſon's TIME-Keeper. See HARRISON and LONGITUDE.

TIMOLEON, a celebrated Corinthian general, who reſtored the Syracuſans to their liberty, and drove the Carthaginians out of Sicily. See SYRACUSE, N° 50—54.

TIMON the *Sceptic*, who is not to be confounded with Timon the *Miſanthrope*, was a Phliaſian, a diſciple of Pyrrho, and lived in the time of Ptolemy Philadelphus. He took ſo little pains to invite diſciples to his ſchool, that it has been ſaid of him, that as the Scythians ſhot flying, Timon gained pupils by running from them. He was fond of rural retirement; and was ſo much addicted to wine, that he held a ſucceſsful conteſt with ſeveral celebrated champions in drinking. Like Lucian, he wrote with ſarcaſtic humour againſt the whole body of philoſophers. The fragments of his ſatirical poem *Silli*, often quoted by the ancients, have been carefully collected by Henry Stephens in his *Poeſis Philoſophica*. Timon lived to the age of 90 years.

TIMON, ſurnamed *Miſanthropos*, or the *Man-hater*, a famous Athenian, who lived about 420 B. C. He was one day aſked, why he loved the young Alcibiades while he deteſted all the reſt of the human race? on which he replied, "It is becauſe I foreſee that he will be the ruin of the Athenians." He carefully avoided all ſorts of company; yet went one day to an aſſembly of the people, and cried with a loud voice, "That he had a fig-tree on which ſeveral perſons had hanged themſelves;

themſelves; but as he intended to cut it down, in order to build a houſe on the place where it ſtood, he gave them notice of it, that if any of them had a mind to hang themſelves, they muſt make haſte and do it ſpeedily." He had an epitaph engraved on his tomb, filled with imprecations againſt thoſe who read it. Shakeſpeare has formed a tragedy on his ſtory.

TIMOR, an iſland of Aſia, in the Eaſt Indian ſea, to the ſouth of the Moluccas, and to the eaſt of the iſland of Java, being 150 miles in length, and 37 in breadth. It abounds in ſandal-wood, wax and honey; and the Dutch have a fort here. The inhabitants are Pagans, and are little better than ſavages; and ſome pretend they had not the uſe of fire many years ago.

TIMOTHEUS, one of the moſt celebrated poet-muſicians of antiquity, was born at Miletus, an Ionian city of Caria, 446 years B. C. He was contemporary with Philip of Macedon and Euripides; and not only excelled in lyric and dithyrambic poetry, but in his performance upon the cithara. According to Pauſanias, he perfected that inſtrument by the addition of four new ſtrings to the ſeven which it had before; though Suidas ſays it had nine before, and that Timotheus only added two, the 10th and 11th, to that number. See LYRE.

With reſpect to the number of ſtrings upon the lyre of Timotheus: The account of Pauſanias and Suidas is confirmed in the famous ſenatus-conſultum againſt him, ſtill extant, preſerved at full length in Boethius. Mr Stillingfleet has given an extract from it, in proof of the ſimplicity of the ancient Spartan muſic. The fact is mentioned in Athenæus; and Caſaubon, in his notes upon that author, has inſerted the whole original text from Boethius, with corrections. The following is a faithful tranſlation of this extraordinary Spartan act of parliament. "Whereas Timotheus the Mileſian, coming to our city, has diſhonoured our ancient muſic, and, deſpiſing the lyre of ſeven ſtrings, has, by the introduction of a greater variety of notes, corrupted the ears of our youth; and by the number of his ſtrings, and the novelty of his melody, has given to our muſic an effeminate and artificial dreſs, inſtead of the plain and orderly one in which it has hitherto appeared; rendering melody infamous, by compoſing in the chromatic inſtead of the enharmonic:——————The kings and the ephori have therefore reſolved to paſs cenſure upon Timotheus for theſe things: and, farther, to oblige him to cut all the ſuperfluous ſtrings of his eleven, leaving only the ſeven tones; and to baniſh him from our city; that men may be warned for the future not to introduce into Sparta any unbecoming cuſtom."———

The ſame ſtory, as related in Athenæus, has this additional circumſtance, That when the public executioner was on the point of fulfilling the ſentence, by cutting off the new ſtrings, Timotheus, perceiving a little ſtatue in the ſame place, with a lyre in his hand of as many ſtrings as that which had given the offence, and ſhowing it to the judges, was acquitted.

It appears from Suidas, that the poetical and muſical compoſitions of Timotheus were very numerous, and of various kinds. He attributes to him 19 nomes, or canticles, in hexameters; 36 proems, or preludes; 18 dithyrambics; 21 hymns; the poem in praiſe of Diana; one panegyric; three tragedies, the Perſians, Phinidas, and Laertes; to which muſt be added a fourth, mentioned by ſeveral ancient authors, called *Niobe*, without forgetting the poem on the birth of Bacchus. Stephen of Byzantium makes him author of 18 books of nomes, or airs, for the cithara, to 8000 verſes; and of 1000 *Προοιμια*, or preludes, for the nomes of the flutes.

Timotheus died in Macedonia, according to Suidas, at the age of 97; though the Marbles, much better authority, ſay at 90; and Stephen of Byzantium fixes his death in the fourth year of the 105th Olympiad, two years before the birth of Alexander the Great; whence it appears, that this Timotheus was not the famous player on the flute ſo much eſteemed by that prince, who was animated to ſuch a degree by his performance as to ſeize his arms; and who employed him, as Athenæus informs us, together with the other great muſicians of his time, at his nuptials. However, by an inattention to dates, and by forgetting that of theſe two muſicians of the ſame name the one was a Mileſian and the other a Theban, they have been hitherto often confounded.

TIMUR-BECK. See TAMERLANE.

TIN, a metallic ſubſtance. See CHEMISTRY and MINERALOGY *Index* for an account of its qualities and ores; and for the method of reducing its ores, ſee ORES, *Reduction of*.

TINCAL, the name by which crude or impure borax is ſometimes known. See BORAX, CHEMISTRY *Index*.

TINCTURE, in *Pharmacy*. See MATERIA MEDICA *Index*.

TINDAL, DR MATTHEW, a famous Engliſh writer, was the ſon of the reverend Mr John Tindal of Beer-Ferres in Devonſhire, and was born about the year 1657. He ſtudied at Lincoln college in Oxford, whence he removed to Exeter, and was afterwards elected fellow of All-Souls. In 1685 he took the degree of doctor of law, and in the reign of James II. declared himſelf a Roman Catholic; but ſoon renounced that religion. After the revolution he publiſhed ſeveral pamphlets in favour of government, the liberty of the preſs, &c. His "Rights of the Chriſtian Church aſſerted," occaſioned his having a violent conteſt with the high-church clergy; and his treatiſe "Chriſtianity as old as the Creation," publiſhed in 1730, made much noiſe, and was anſwered by ſeveral writers, particularly by Dr Conybeare, Mr Forſter, and, Dr Leland. Dr Tindal died at London in Auguſt 1733. He left in manuſcript a ſecond volume of his "Chriſtianity as old as the Creation;" the preface to which has been publiſhed. Mr Pope has ſatirized Dr Tindal in his Dunciad.

TINDALE, WILLIAM. See TYNDALE.

TINNING, the covering or lining any thing with melted tin, or tin reduced to a very fine leaf. Looking-glaſſes are foliated or tinned with plates of beaten tin, the whole bigneſs of the glaſs, applied or faſtened thereto by means of quickſilver. See *FOLIATING of Looking Glaſſes*.

TINNITUS AURIUM, a noiſe in the ears like the continued ſound of bells, very common in many diſorders, particularly in nervous fevers.

TIPPERARY, a county of the province of Munſter in Ireland, bounded on the weſt by thoſe of Limerick and Clare, on the eaſt by the county of Kilkenny and Queen's county, on the ſouth by the county of Water-

ford,

Gough's edit. of Camden's Britannia.

ford, and on the north and north-eaſt by King's-county and the territory of the ancient O'Carols. It extends about 42 miles in length, 27 in breadth, containing 599,500 acres, divided into 12 baronies, in which are ſeveral market towns and boroughs. It ſends eight members to parliment, viz. two for the county, two for the city of Caſhel, and two for each of the boroughs of Clonmell, Fetherd, and Thurles. The north part of it is mountainous and cold; but in the ſouth the air is milder, and the ſoil much more fertile, producing plenty of corn, and good paſture for the numerous herds of cattle and flocks of ſheep with which it abounds. The north part is called *Ormond*, and for a long time gave the title of *earl*, and afterwards of *marquis* and *duke*, to the noble family of Butler, deſcended from a ſiſter of Thomas à Becket archbiſhop of Canterbury, till, at the acceſſion of George I. the laſt duke was attainted of high-treaſon, and died abroad. In that part of the county, the family had great prerogatives and privileges granted them by Edward III. Another diſtrict in this county was anciently called the *County of the Holy Croſs of Tipperary*, from a famous abbey in it ſtyled *Holy Croſs*, on account of a piece of Chriſt's croſs that was ſaid to be preſerved there. This abbey and diſtrict enjoyed alſo ſpecial privileges in former times. The remains of the abbey, or rather the ſpot where it ſtood, are ſtill held in great veneration, and much reſorted to by the Roman Catholics.

TIPSTAFF, an officer who attends the judges with a kind of ſtaff tipped with ſilver, and takes into his charge all priſoners who are committed or turned over at a judge's chambers.

TIPULA, the CRANE-FLY; a genus of inſects belonging to the order of *diptera*. See ENTOMOLOGY *Index*.

TIRE, in the ſea language, is a row of cannon placed along a ſhip's ſide, either above upon deck, or below, diſtinguiſhed by the epithets of *upper* and *lower tires*.

TIROL, or TYROL, a county of Germany in the circle of Auſtria, under which may be included the territories belonging to the biſhops of Brixen, Trent, and Chur, the Teutonic Order, and the prince of Deitrichſtein, the Auſtrian ſeigniories before the Arlberg, and the Auſtrian diſtricts in Swabia. It is 150 miles in length, and 120 in breadth, and contains 28 large towns.

The face of the country is very mountainous. Of theſe mountains, ſome have their tops always buried in ſnow; others are covered with woods, abounding with a variety of game; and others are rich in metals, and marble of all colours. Of the lower, ſome yield plenty of corn, others wine, and woods of cheſnut trees. The valleys are exceeding fertile alſo, and pleaſant. In ſome places conſiderable quantities of flax are raiſed, in others there is a good breed of horſes and horned cattle; and, among the mountains, abundance of chamois and wild goats. In this country are alſo found precious ſtones of ſeveral ſorts; as garnets, rubies, amethyſts, emeralds, and a ſpecies of diamonds, agates, carnelians, calcedonies, malachites, &c.; nor is it without hot baths, acid waters, ſalt pits, mines of ſilver, copper, and lead, mineral colours, alum, and vitriol. The principal river of Tirol is the Inn, which, after traverſing the country, and receiving a number of leſſer ſtreams into it, enters Bavaria, in which, at Paſſau, it falls into the Danube. The men here are very tall, robuſt, and vigorous; the women alſo are ſtout, and generally fair; and both ſexes have a mixture of the Italian and German in their tempers and characters. As there is little trade or manufacture in the country, except what is occaſioned by the mines and ſalt works, many of the common people are obliged to ſeek a ſubſiſtence elſewhere. A particular kind of ſalutation is uſed all over Tirol. When a perſon comes into a houſe, he ſays, "Hail! Jeſus Chriſt:" the anſwer is, "May Chriſt be raiſed, and the Holy Virgin his mother." Then the maſter of the houſe takes the viſitor by the hand. This ſalutation is fixed up in print at all the doors, with an advertiſement tacked to it, importing, that Pope Clement XI. granted 100 days indulgence, and a plenary abſolution, to thoſe who ſhould pronounce the ſalutation and anſwer, as often as they did it. The emperor has forts and citadels ſo advantageouſly ſituated on rocks and mountains all over the country, that they command all the valleys, avenues, and paſſes that lead unto it. The inhabitants, however, to keep them in good humour, are more gently treated, and not ſo highly taxed as thoſe of the other hereditary countries. As to the ſtates, they are much the ſame in this country as in the other Auſtrian territories, except that the peaſants here ſend deputies to the diets. Tirol came to the houſe of Auſtria in the year 1363, when Margaret, counteſs thereof, bequeathed it to her uncles the dukes of Auſtria. The arms of Tirol are an eagle gules, in a field argent. The counts of Trap are hereditary ſtewards; the lords of Gloſz, chamberlains; the princes of Trautſon, marſhals; the counts of Wolkenſtein, maſters of the horſe and carvers; the houſe of Spaur, cup-bearers; the counts of Kungl, ſewers and rangers; the counts of Brandis, keepers of the jewels; the houſe of Welſperg, purveyors and ſtaff-bearers; and the counts of Coalto, falconers. Beſides the governor, here are three ſovereign colleges, ſubordinate to the court at Vienna, which ſit at Inſpruck, and have their different departments. Towards the expences of the military eſtabliſhment of this country, the proportion is 100,000 florins yearly; but no more than one regiment of foot is generally quartered in it.

Tirol is divided into ſix quarters, as they are called; namely, thoſe of the Lower and Upper Innthal, Vintſgow, Etch, Eiſack, and Puſterthal.

TITAN, in fabulous hiſtory, the ſon of Cœlus and Terra, and the elder brother of Saturn, ſuffered the latter to enjoy the crown, on condition that he ſhould bring up none of his male iſſue, by which means the crown ſhould at length revert to him; but Jupiter being ſpared by the addreſs of Rhea, Saturn's wife, Titan and his children were ſo enraged at ſeeing their hopes fruſtrated, that they took up arms to revenge the injury; and not only defeated Saturn, but kept him and his wife priſoners till he was delivered by Jupiter, who defeated the Titans; when from the blood of theſe Titans ſlain in the battle, proceeded ſerpents, ſcorpions, and all venomous reptiles. See SATURN.

Such is the account given by the poets of this family of Grecian and Roman gods. From the fragments of Sanchoniatho, however, and other ancient writers, many learned men have inferred that the Titans were an early race of ambitious heroes, who laid the foundation of that idolatry which quickly overſpread the world, and that by aſſuming the names of the luminaries of heaven they contrived to get themſelves every where adored as the *Dii majorum gentium*. That the word *Titan* ſignifies the ſun, there can indeed be very little doubt. Every one knows that ſuch was its ſignification in the Æolic dialect; and as it is evidently compounded of *Ti*, which, in ſome oriental tongues, ſignifies *bright* or *clear*, and *Tan*, which ſignifies a *country* or the *earth*, it may be ſafely concluded that *Titan* was the name of the ſun before the word was imported into Greece. But the great queſtion among antiquarians is, of what country was that race which, aſſuming to themſelves the names of the heavenly bodies, introduced into the world that ſpecies of idolatry which is known by the appellation of *Hero-worſhip*?

M. Pezron, in a work publiſhed many years ago, and entitled *The Antiquities of Nations*, maintains that the Titans were a family of Sacæ or Scythians, who made their firſt appearance beyond Media and Mount Imaus, in the upper regions of Aſia; that they were the deſcendants of Gomer the ſon of Japheth and grandſon of Noah; and that after conquering a great part of the world, upon entering Upper Phrygia, they quitted their ancient name of Gomerians or Cimmerians, and aſſumed that of Titans. All this, he ſays, happened before the birth of Abraham and the foundation of the Aſſyrian monarchy; and he makes Uranus, their ſecond prince in the order of ſucceſſion, to have conquered Thrace, Greece, the iſland of Crete, and a great part of Europe. Uranus was ſucceeded by Saturn, and Saturn by Jupiter, who flouriſhed, he ſays, 300 years before Moſes, and divided his vaſt empire between himſelf, his brother Pluto, and his couſin-german Atlas, who was called *Telamon*. For the truth of this genealogy of the Titans M. Pezron appeals to the moſt approved Greek hiſtorians; but unluckily for his hypotheſis, theſe writers have not a ſingle ſentence by which it can be fairly ſupported. It ſuppoſes not only the great antiquity of the Scythians, but likewiſe their early progreſs in arts and ſciences, contrary to what we have proved in other articles of this work. See SCULPTURE, n° 4 and 5. and SCYTHIA.

Others, taking the fragment of Sanchoniatho's Phenician hiſtory for their guide, have ſuppoſed the Titans to have been the deſcendants of Ham. Of this opinion was Biſhop Cumberland; and our learned friend Dr Doig, to whom we have been indebted for greater favours, indulged us with the peruſal of a manuſcript, in which, with erudition and ingenuity ſtruggling for the pre-eminence, he traces that impious family from the profane ſon of Noah, and ſhows by what means they ſpread the idolatrous worſhip of themſelves over the greater part of the ancient world. Cronus, of whoſe exploits ſome account has been given elſewhere (ſee SANCHONIATHO), he holds to be Ham; and tracing the progreſs of the family from Phœnicia to Cyprus, from Cyprus to Rhodes, thence to Crete, and from Crete to Samothrace, he finds reaſon to conclude that the branch called *Titans* or *Titanides* flouriſhed about the era of Abraham, with whom, or with his ſon Iſaac, he thinks the Cretan Jupiter muſt have been contemporary. As they proceeded from countries which were the original ſeat of civilization to others in which mankind had ſunk into the groſſeſt barbariſm, it was eaſy for them to perſuade the ignorant inhabitants that they derived the arts of civil life from their parent the ſun, and in conſequence of their relation to him to aſſume to themſelves divine honours. To aſk how they came to think of ſuch groſs impiety, is a queſtion as fooliſh as it would be to aſk how Ham their anceſtor became ſo wicked as to entail the curſe of God upon himſelf and his poſterity. The origin of evil is involved in difficulties; but leaving all inquiries into it to be proſecuted by the metaphyſician and moraliſt, it is ſurely more probable that the worſhip of dead men originated among the deſcendants of Ham than among thoſe of Shem and Japheth; and that the fragment of Sanchoniatho, when giving an account of the origin of the Titans, the undoubted authors of that worſhip, is more deſerving of credit than the fabulous and comparatively late writers of Greece and Rome.

TITHES, in eccleſiaſtical law, are defined to be the tenth part of the increaſe, yearly ariſing and renewing from the profits of lands, the ſtock upon lands, and the perſonal induſtry of the inhabitants: the firſt ſpecies being uſually called *predial*, as of corn, graſs, hops, and wood; the ſecond *mixed*, as of wool, milk, pigs, &c. conſiſting of natural products, but nurtured and preſerved in part by the care of man; and of theſe the tenth muſt be paid in groſs; the third *perſonal*, as of manual occupations, trades, fiſheries, and the like; and of theſe only the tenth-part of the clear gains and profits is due.

We ſhall, in this article, conſider, 1. The original of the right of tithes. 2. In whom that right at preſent ſubſiſts. 3. Who may be diſcharged, either totally or in part, from paying them.

1. As to their original, we will not put the title of the clergy to tithes upon any divine right; though ſuch a right certainly commenced, and we believe as certainly ceaſed, with the Jewiſh theocracy. Yet an honourable and competent maintenance for the miniſters of the goſpel is undoubtedly *jure divino*, whatever the particular mode of that maintenance may be. For, beſides the poſitive precepts of the New Teſtament, natural reaſon will tell us, that an order of men who are ſeparated from the world, and excluded from other lucrative profeſſions for the ſake of the reſt of mankind, have a right to be furniſhed with the neceſſaries, conveniences, and moderate enjoyments of life, at their expence; for whoſe benefit they forego the uſual means of providing them. Accordingly all municipal laws have provided a liberal and decent maintenance for their national prieſts or clergy; ours, in particular, have eſtabliſhed this of tithes, probably in imitation of the Jewiſh law: and perhaps, conſidering the degenerate ſtate of the world in general, it may be more beneficial to the Engliſh clergy to found their title on the law of the land, than upon any divine right whatſoever, unacknowledged and unſupported by temporal ſanctions.

Blackſt. Comment.

We cannot preciſely aſcertain the time when tithes were firſt introduced into this country. Poſſibly they were contemporary with the planting of Chriſtianity among the Saxons by Auguſtin the monk, about the end of the ſixth century. But the firſt mention of them which we have met with in any written Engliſh law, is a conſtitutional decree, made in a ſynod held A. D. 786, wherein the payment of tithes in general is ſtrongly enjoined. This canon or decree, which at firſt bound not the laity, was effectually confirmed by two kingdoms of the heptarchy, in their parliamentary conventions of eſtates, reſpectively conſiſting of the kings of Mercia and Northumberland, the biſhops, dukes, ſenators, and people. Which was a few years later than the time that Charlemagne eſtabliſhed the payment of them in France, and made that famous diviſion of them into four parts; one to maintain the edifice of the church, the ſecond to ſupport the poor, the third the biſhop, and the fourth the parochial clergy.

The next authentic mention of them is in the *fœdus Edwardi et Guthruni;* or the laws agreed upon between King Guthrun the Dane, and Alfred and his ſon Edward the Elder, ſucceſſive kings of England, about the year 900. This was a kind of treaty between thoſe monarchs, which may be found at large in the Anglo-Saxon laws: wherein it was neceſſary, as Guthrun was a Pagan, to provide for the ſubſiſtence of the Chriſtian clergy under his dominion; and accordingly, we find the payment of tithes not only enjoined, but a penalty added upon non-obſervance: which law is ſeconded by the laws of Athelſtan, about the year 930. And this is as much as can certainly be traced out with regard to their legal original.

2. We are next to conſider the perſons to whom tithes are due. Upon their firſt introduction, though every man was obliged to pay tithes in general, yet he might give them to what prieſts he pleaſed; which were called *arbitrary conſecrations of tithes;* or he might pay them into the hands of the biſhop, who diſtributed among his dioceſan clergy the revenues of the church, which were then in common. But when dioceſes were divided into pariſhes, the tithes of each pariſh were allotted to its own particular miniſter; firſt by common conſent or the appointments of lords of manors, and afterwards by the written law of the land.

Arbitrary conſecrations of tithes took place again afterwards, and were in general uſe till the time of King John. This was probably owing to the intrigues of the regular clergy, or monks of the Benedictine and other orders, under Archbiſhop Dunſtan and his ſucceſſors; who endeavoured to wean the people from paying their dues to the ſecular or parochial clergy (a much more valuable ſet of men than themſelves), and were then in hopes to have drawn, by ſanctimonious pretences to extraordinary purity of life, all eccleſiaſtical profits to the coffers of their own ſocieties. And this will naturally enough account for the number and riches of the monaſteries and religious houſes which were founded in thoſe days, and which were frequently endowed with tithes. For a layman, who was obliged to pay his tithes ſomewhere, might think it good policy to erect an abbey, and there pay them to his own monks, or grant them to ſome abbey already erected: ſince for this donation, which really coſt the patron little or nothing, he might, according to the ſuperſtition of the times, have maſſes for ever ſung for his ſoul. But in proceſs of years, the income of the poor laborious pariſh-prieſts being ſcandalouſly reduced by theſe arbitrary conſecrations of tithes, it was remedied by Pope Innocent III. about the year 1200, in a decretal epiſtle ſent to the archbiſhop of Canterbury, and dated from the palace of Lateran: which has occaſioned Sir Henry Hobart and others to miſtake it for a decree of the council of Lateran, held A. D. 1179, which only prohibited what was called the *infeodation of tithes*, or their being granted to mere laymen; whereas this letter of Pope Innocent to the archbiſhop enjoined the payment of tithes to the parſons of the reſpective pariſhes where every man inhabited, agreeable to what was afterwards directed by the ſame pope in other countries. This epiſtle, ſays Sir Edward Coke, bound not the lay ſubjects of this realm; but being reaſonable and juſt, it was allowed of, and ſo became *lex terræ.* This put an effectual ſtop to all the arbitrary conſecrations of tithes; except ſome footſteps which ſtill continue in thoſe portions of tithes which the parſon of one pariſh hath, though rarely, a right to claim in another: for it is now univerſally held, that tithes are due, of common right, to the parſon of the pariſh, unleſs there be a ſpecial exemption. This parſon of the pariſh may be either the actual incumbent, or elſe the appropriator of the benefice; appropriations being a method of endowing monaſteries, which ſeems to have been deviſed by the regular clergy, by way of ſubſtitution to arbitrary conſecrations of tithes.

3. We obſerved that tithes are due of common right to the parſon, unleſs by ſpecial exemption; let us therefore ſee, *thirdly*, who may be exempted from the payment of tithes, and how lands and their occupiers may be exempted or diſcharged from the payment of tithes, either in part or totally; firſt, by a real compoſition; or, ſecondly, by cuſtom or preſcription.

Firſt, A real compoſition is when an agreement is made between the owner of the lands and the parſon or vicar, with the conſent of the ordinary and the patron, that ſuch lands ſhall for the future be diſcharged from payment of tithes, by reaſon of ſome land or other real recompenſe given to the parſon in lieu and ſatisfaction thereof. This was permitted by law, becauſe it was ſuppoſed that the clergy would be no loſers by ſuch compoſition; ſince the conſent of the ordinary, whoſe duty it is to take care of the church in general, and of the patron, whoſe intereſt it is to protect that particular church, were both made neceſſary to render the compoſition effectual: and hence have ariſen all ſuch compoſitions as exiſt at this day by force of the common law. But experience ſhowing that even this caution was ineffectual, and the poſſeſſions of the church being by this and other means every day diminiſhed, the diſabling ſtatute 13 Eliz. c. 10. was made; which prevents, among other ſpiritual perſons, all parſons and vicars from making any conveyances of the eſtates of their churches, other than for three lives or 21 years. So that now, by virtue of this ſtatute, no real compoſition made ſince the 13 Eliz. is good for any longer term than three lives or 21 years, though made by conſent of the patron and ordinary: which has indeed effectually demoliſhed this kind of traffic; ſuch compoſitions being now rarely heard of, unleſs by authority of parliament.

Secondly, a diſcharge by cuſtom or preſcription, is where time out of mind ſuch perſons or ſuch lands have been either partially or totally diſcharged from the payment of tithes. And this immemorial uſage is binding upon all parties; as it is in its nature an evidence of univerſal conſent and acquieſcence, and with reaſon ſuppoſes a real compoſition to have been formerly made. This cuſtom or preſcription is either *de modo decimandi*, or *de non decimando.*

A *modus decimandi*, commonly called by the ſimple name of a *modus* only, is where there is by cuſtom a particular manner of tithing allowed, different from the general law of taking tithes in kind, which are the actual tenth-part of the annual increaſe. This is ſometimes a pecuniary compenſation, as twopence an acre for the tithe of land: ſometimes it is a compenſation in work and labour, as that the parſon ſhall have only the twelfth cock of hay, and not the tenth, in conſideration of the owner's making it for him: ſometimes, in lieu of a large quantity of crude or imperfect tithe, the parſon ſhall have a leſs quantity when arrived at greater maturity, as a couple of fowls in lieu of tithe-eggs, and the like. Any means, in ſhort, whereby the general law of tithing is altered, and a new method of taking them is introduced, is called a *modus decimandi*, or ſpecial manner of tithing.

A preſcription *de non decimando* is a claim to be entirely diſcharged of tithes, and to pay no compenſation in lieu of them. Thus the king by his prerogative is diſcharged from all tithes. So a vicar ſhall pay no tithes to the rector, nor the rector to the vicar, for *eccleſia decimas non ſolvit eccleſiæ*. But theſe perſonal privileges (not ariſing from or being annexed to the land) are perſonally confined to both the king and the clergy; for their tenant or leſſee ſhall pay tithes, though in their own occupation their lands are not generally tithable. And, generally ſpeaking, it is an eſtabliſhed rule, that in lay hands, *modus de non decimando non valet*. But ſpiritual perſons or corporations, as monaſteries, abbots, biſhops, and the like, were always capable of having their lands totally diſcharged of tithes by various ways: as, 1. By real compoſition. 2. By the pope's bull of exemption. 3. By unity of poſſeſſion; as when the rectory of a pariſh, and lands in the ſame pariſh, both belonged to a religious houſe, thoſe lands were diſcharged of tithes by this unity of poſſeſſion. 4. By preſcription; having never been liable to tithes, by being always in ſpiritual hands. 5. By virtue of their order; as the Knights Templars, Ciſtercians, and others, whoſe lands were privileged by the pope with a diſcharge of tithes. Though, upon the diſſolution of abbeys by Henry VIII. moſt of theſe exemptions from tithes would have fallen with them, and the lands become tithable again, had they not been ſupported and upheld by the ſtatute 31 Henry VIII. c. 13. which enacts, that all perſons who ſhould come to the poſſeſſion of the lands of any abbey then diſſolved, ſhould hold them free and diſcharged of tithes, in as large and ample a manner as the abbeys themſelves formerly held them. And from this original have ſprung all the lands which being in lay hands, do at preſent claim to be tithe-free: for if a man can ſhow his lands to have been ſuch abbey-lands, and alſo immemorially diſcharged of tithes by any of the means before mentioned, this is now a good preſcription *de non decimando*. But he muſt ſhow both theſe requiſites: for abbey-lands, without a ſpecial ground of diſcharge, are not diſcharged of courſe; neither will any preſcription *de non decimando* avail in total diſcharge of tithes, unleſs it relates to ſuch abbey-lands.

It is univerſally acknowledged that the payment of tithes in kind is a great diſcouragement to agriculture. They are inconvenient and vexatious to the huſbandman, and operate as an impolitic tax upon induſtry. The clergyman, too, frequently finds them troubleſome and precarious; his expences in collecting are a conſiderable drawback from their value, and his juſt rights are with difficulty ſecured: he is too often obliged to ſubmit to impoſition, or is embroiled with his pariſhioners in diſputes and litigations, no leſs irkſome to his feelings than prejudicial to his intereſt, and tending to prevent thoſe good effects which his precepts ſhould produce. It is therefore of the utmoſt importance to parochial tranquillity, and even to religion, that ſome juſt and reaſonable ſtandard of compoſition could be fixed. Land has been propoſed, but in the preſent ſtate of the diviſion of property this is impoſſible: and as money is continually changing in its value, it would alſo be a very improper ſtandard, unleſs ſome plan could be formed by which the compoſition could be increaſed as the value of money diminiſhes. A plan of this kind has been publiſhed in the Tranſactions of the Society inſtituted at Bath, vol. iv. which thoſe who are intereſted in this ſubject may conſult for farther information.

TITHING, (*Tithinga*, from the Sax. *Theothunge*, *i. e. Decuriam*), a number or company of ten men, with their families, knit together in a kind of ſociety, and all bound to the king, for the peaceable behaviour of each other. Anciently no man was ſuffered to abide in England above forty days, unleſs he were enrolled in ſome tithing.—One of the principal inhabitants of the tithing was annually appointed to preſide over the reſt, being called the *tithing-man*, the head-borough, and in ſome countries the borſeholder, or borough's ealder, being ſuppoſed the diſcreeteſt man in the borough, town, or tithing. The diſtribution of England into tithings and hundreds is owing to King Alfred. See BORSEHOLDER.

TITIANO VECELLI, or TITIAN, the moſt univerſal genius for painting of all the Lombard-ſchool, the beſt colouriſt of all the moderns, and the moſt eminent for hiſtories, portraits, and landſcapes, was born at Cadore, in the province of Friuli, in the ſtate of Venice, in 1477, or in 1480 according to Vaſari and Sandrart. His parents ſent him at ten years of age to one of his uncles at Venice, who finding that he had an inclination to painting, put him to the ſchool of Giovanni Bellino.

Pilkington's Dictionary of Painters.

But as ſoon as Titian had ſeen the works of Giorgione, whoſe manner appeared to him abundantly more elegant, and leſs conſtrained than that of Bellino, he determined to quite the ſtyle to which he had ſo long been accuſtomed, and to purſue the other that recommended itſelf to him, by having more force, more relief, more nature, and more truth. Some authors affirm, that he placed himſelf as a diſciple with Giorgione; yet others only ſay, that he cultivated an intimacy with him; but it is undoubtedly certain that he ſtudied with that great maſter; that he learned his method of blending and uniting the colours; and practiſed his manner ſo effectually, that ſeveral of the paintings of Titian were taken for the performances of Giorgione; and then his ſucceſs inſpired that artiſt with an invincible jealouſy of Titian, which broke off their connection for ever after.

The reputation of Titian roſe continually; every new work contributed to extend his fame through all Europe; and he was conſidered as the principal ornament of the age in which he flouriſhed. And yet, Sandrart obſerves that amidſt all his applauſe, and conſtant employment at Venice, his income and fortune were inconſiderable;

and he was more remarkable for the extenſiveneſs of his talents, than for the affluence of his circumſtances. But when his merit was made known to the emperor Charles V. that monarch knew how to ſet a juſt value on his ſuperior abilities; he enriched him by repeated bounties, allowed him a conſiderable penſion, conferred on him the honour of knighthood, and what was ſtill more, honoured him with his friendſhip. He painted the portrait of that benefactor ſeveral times; and it is recorded by Sandrart, that one day, while the emperor was ſitting for his picture, a pencil happening to drop from the painter, he ſtooped, took it up, and returned it; obligingly anſwering to the modeſt apology of the artiſt (who bluſhed at the condeſcenſion of ſo great a monarch), that the merit of a Titian was worthy of the attendance of an emperor.

The excellence of Titian was not ſo remarkably apparent in the hiſtorical compoſitions which he painted as in his portraits and landſcapes, which ſeem to be ſuperior to all competition; and even to this day, many of them preſerve their original beauty, being as much the admiration of the preſent age as they have deſervedly been of the ages paſt.—It is obſerved of Titian by moſt writers, that in the different periods of his life he had four different manners; one reſembling his firſt inſtructor Bellino, which was ſomewhat ſtiff; another, in imitation of Giorgione, more bold, and full of force; his third manner was the reſult of experience, knowledge, and judgement, beautifully natural, and finiſhed with exquiſite care, which manner was peculiarly his own; and in thoſe pictures which he painted between the years of approaching old age and his death may be noticed his fourth manner. His portraits were very differently finiſhed in his early, and in his latter time, according to the teſtimony of Sandrart. At firſt he laboured his pictures highly, and gave them a poliſhed beauty and luſtre, ſo as produce their effect full as well when they were examined cloſely as when viewed at a diſtance; but afterwards, he ſo managed his penciling, that their greateſt force and beauty appeared at a more remote view, and they pleaſed leſs when they were beheld more nearly. So that many of thoſe artiſts who ſtudied to imitate him, being miſled by appearances which they did not ſufficiently conſider, have imagined that Titian executed his work with readineſs and a maſterly rapidity; and concluded that they ſhould imitate his manner moſt effectually by a freedom of hand and a bold pencil: Whereas in reality, Titian took abundance of pains to work up his pictures to ſo high a degree of perfection; and the freedom that appears in the handling was entirely effected by a ſkilful combination of labour and judgement.

It cannot be truly affirmed, that Titian equalled the great maſters of the Roman ſchool in deſign; but he always took care to diſpoſe his figures in ſuch attitudes as ſhowed the moſt beautiful parts of the body. His taſte in deſigning men was not generally ſo correct or elegant as it appeared in his boys and female figures; but his colouring had all the look of real fleſh, his figures breathe. He was not ſo bold as Giorgione, but in tenderneſs and delicacy he proved himſelf much ſuperior to him and all other artiſts. The expreſſion of the paſſions was not his excellence, though even in that reſpect many of his figures merited the juſteſt commendation; but he always gave his figures an air of eaſe and dignity. His landſcapes are univerſally allowed to be unequalled, whether we conſider the forms of his trees, the grand ideas of nature which appear in his ſcenery, or his diſtances which agreeably delude and delight the eye of every obſerver; and they are executed with a light, tender, and mellow pencil. He learned from nature the harmony of colours, and his tints ſeem aſtoniſhing, not only for their force, but their ſweetneſs; and in that reſpect his colouring is accounted the ſtandard of excellence to all profeſſors of the art.

It would prove almoſt an endleſs taſk to enumerate the variety of works executed by this illuſtrious artiſt, at Rome, Venice, Bologna, and Florence, as well as thoſe which are to be ſeen in other cities of Italy, in England, Spain, Germany, and France; but there are two, which are mentioned as being truly admirable. One is, a Laſt Supper, preſerved in the refectory at the Eſcurial in Spain, which is inimitably fine; the other is at Milan, repreſenting Chriſt crowned with thorns. The principal figure in the latter has an attitude full of grace and dignity more than mortal, and the countenance ſhows a benevolence and humility, combined with dignity and pain, which no pencil but that of Titian could ſo feelingly have deſcribed. It is admirably coloured, and tenderly and delicately penciled; the heads are wonderfully beautiful, the compoſition excellent, and the whole has a charming effect by the chiaroſcuro.

He was of ſo happy a conſtitution, that he was never ill till the year 1576, when he died of the plague, at 99 years of age. His diſciples were Paulo Veroneſe, Giacomo Tintoret, Giacomo de Porte Baſſano, and his ſons.

TITLARK. See ALAUDA, ORNITHOLOGY *Index*.

TITLE, an appellation of dignity or rank given to princes and perſons of diſtinction.

Titles were not ſo common among the ancient Greeks or Romans as they are in modern times. Till the reign of Conſtantine the title of *Illuſtrious* was never given except to thoſe who were diſtinguiſhed in arms or letters: But at length it became hereditary in the families of princes, and every ſon of a prince was illuſtrious. The title of *Highneſs* was formerly given only to kings. The kings of England before the reign of Henry VIII. were addreſſed by the title of *your Grace*. That monarch firſt aſſumed the title of *Highneſs*, and afterwards that of *Majeſty*. The title of majeſty was firſt given him by Francis I. in their interview in 1520. Charles V. was the firſt king of Spain who aſſumed the ſame title.

Princes, nobles, and clergy, generally have one title derived from their territories and eſtates, and another derived from their rank or from ſome other remarkable circumſtance. The pope is called the *Biſhop of Rome*, and has the title of *Holineſs*. A cardinal has his name generally from ſome church, and is ſaluted by the name of *Eminent*, or *moſt Eminent*. An archbiſhop, beſides being named from his dioceſe, is called *his Grace* and *moſt Reverend*: a biſhop is alſo diſtinguiſhed by the name of his dioceſe, and has the title of *his Lordſhip* and *right Reverend*. Inferior clergymen are denominated *Reverend*.

The titles of crowned heads derived from their dominions it is unneceſſary to mention. It will be ſufficient to mention thoſe by which they are addreſſed. To an emperor is given the title of *Imperial Majeſty*; to kings, that of *Majeſty*; to the princes of Great Britain, *Royal Highneſs*; to thoſe of Spain, *Infant*; to electors, *Electoral Highneſs*; to the grand duke of Tuſcany, *Moſt Serene Highneſs*; to the other princes of Italy and Germany, *Highneſs*; to the doge of Venice, *Moſt Serene Prince*; to the grand-maſter of Malta, *Eminence*; to nuncios and ambaſſadors of crowned heads, *Excellency*; to dukes, *Grace*; to marquiſſes, earls, and barons, *Lordſhip*.

The emperor of China, among his titles, takes that of *Tien Su*, " Son of Heaven." The Orientals, it is obſerved, are exceedingly fond of titles: the ſimple governor of Schiras, for inſtance, after a pompous enumeration of qualities, lordſhips, &c. adds the titles of *Flower of Courteſy*, *Nutmeg of Conſolation*, and *Roſe of Delight*.

TITLE, in *Law*, denotes any right which a perſon has to the poſſeſſion of a thing, or an authentic inſtrument whereby he can prove his right. See the articles RIGHT, PROPERTY, &c.

TITLE to the Crown in the Britiſh Conſtitution. See SUCCESSION.

TITMOUSE. See PARUS, ORNITHOLOGY *Index*.

TITULAR. denotes a perſon inveſted with a title, in virtue of which he holds an office or benefice, whether he perform the functions thereof or not.

TITUS VESPASIANUS, the Roman emporer, the ſon of Veſpaſian; of whom it is related, that not being able to recollect any remarkable good action he had done on a certain day, he exclaimed, " I have loſt a day!" He might truly be called the *father of his people*; and though Rome laboured under various public calamities during his reign, ſuch was his equitable and mild adminiſtration, that he conſtantly preſerved his popularity. He was a great lover of learning, and compoſed ſeveral poems. He reigned but two years; and it is thought Domitian his brother poiſoned him, A. D. 81. aged 41. See (*Hiſtory of*) ROME.

TIVIOT HILLS. See CHEVIOT.

TIVOLI, the modern name of TIBUR.

TOAD. See RANA, ERPETOLOGY *Index*.

TOAD-Fiſh. See LOPHIUS, ICHTHYOLOGY *Index*.

TOAD-Flax. See ANTIRRHINUM, BOTANY *Index*.

TOAD Stone, an argillaceous ſtone. See GEOLOGY.

TOBACCO. See NICOTIANA, BOTANY *Index*, and SNUFF.

TOBACCO-Pipe-Fiſh. See FISTULARIA, ICHTHYOLOGY *Index*.

TOBACCO Pipes, Manufacture of. The art of making tobacco-pipes, or, as it is commonly called, *pipe-making*, though one of the ſimpleſt ſpecies of pottery, is ſufficiently curious to merit deſcription in a dictionary of arts and ſciences.

The proceſs of pipe-making may be divided into ſix ſtages; viz. 1. Beating or preparing the clay; 2. Rolling; 3. Moulding; 4. Trimming; 5. Drying; and 6. Burning.

Preparation of the Clay.—The fine white clay employed by the pipe-makers, is dug from the quarries in maſſes of about a cubic foot each. Before it can be uſed in the manufacture of tobacco-pipes, it muſt be reduced to the conſiſtence of a tough paſte. To effect this, after its outer ſurface has been cleared from dirt or duſt, it is broken into ſmall pieces about as large as a gooſe's egg, and thrown into a tub with ſuch a quantity of ſoft water as experience has ſhewn to be ſufficient to bring it to the proper conſiſtence. After lying till it has ſoaked up all the water, which uſually requires from 12 to 24 hours, it is taken from the tub and laid on a thick ſtrong wooden bench. Here it is beaten by a heavy four-ſquare iron inſtrument, in ſuch a manner as to cut it from one end to the other into very thin ſlices. It requires conſiderable addreſs to perform this operation, and it is ſurpriſing how thin the workmen will ſometimes cut the ſlices, and how equally they will thus divide the clay. This beating is continued, alternately folding up the clay and ſlicing it, till the whole is perfectly ſmooth. It is then ready for rolling.

Rolling.—The operation of rolling reduces the clay into pieces of a proper ſize and length for making pipes, and almoſt to the proper form. The roller ſits at a bench with a ſmooth board before him, and holds in his hand another ſmooth board about 18 inches long, four broad, and about half an inch thick, having one end rounded off on one ſide, ſo as to produce a correſponding hollow in the clay. He now takes a piece of the beaten clay, and rolls it out, firſt with his hands, and then with the board, till it acquire the form of a long ſlender cylinder, with one end conſiderably larger than the reſt. This large end is to form the bole, and the cylinder the ſhank of the future pipe. The pieces of clay thus formed are laid beſide each other on a flat board, and are now ready for moulding.

Moulding.—This is the moſt complex operation, and requires the greateſt number of inſtruments. The principal of theſe is the mould, which is compoſed of two long pieces of iron, formed ſo as to join together, and having their correſponding ſides cut into the ſhape of half a tobacco pipe, each piece being hollowed ſo as to form half a ſlender cylinder, with a larger cavity at the upper end, and at ſuch an angle as it is intended the bole of the pipe ſhall make with the ſhank. Juſt above that part of each ſide of the mould which ſtands beyond what is intended to form the bole, there is a notch for admitting a knife to cut off the ſuperfluous clay. To receive the united mould there is a vice, having at one end two upright poſts, between which moves a long lever, and to this lever, near the poſts, there is looſely attached a piece of iron ending below in a ſmooth conical head, capable of entering the large opening of the mould, but rather ſmaller than that opening, ſo as that when forced down into it, a ſufficient thickneſs of clay may be left between the cone and the ſides of the mould, to form the bole of the pipe. One ſide of this vice is fixed, and the other moveable, towards the former. The moveable ſide has attached to it an iron ſcrew with a very long lever as its handle, ſo that by turning the ſcrew one way or the other, the moveable ſide of the vice may be forced nearer the fixed ſide, or ſuffered to return to its original poſition.

Beſides theſe principal inſtruments, the moulder requires a ſlender ſteel wire, fixed in a handle at one end, and having its other extremity formed into a very ſmall head; a ſaucer containing wool well impregnated with oil, and a ſmall woollen or cotton bruſh.

When about to mould his pipes, he lays hold of the ſhank of one of the rolled pieces, and with great dexterity, which practice alone can teach, he paſſes up the oiled wire through its whole length, till he finds it arrived at the commencement of the larger extremity of the clay. This extremity he then bends to the proper angle, and having oiled the inſide of each part of his mould, he lays the piece of clay with the wire in it, into one part of the mould, and covers it with the other. He now puts the mould containing the clay into the vice, and with the left hand turning round the handle of the ſcrew, ſo as to fix the mould firmly within the vice, he, with the right hand, preſſes down the lever with its conical head, and thus forms the cavity of the bole. He now withdraws the mould, cuts off with his knife the ſuperfluous clay from the bole, opens the mould, takes out the pipe, and now only withdraws the wire. He then lays the moulded pipe on a flat board, in the ſame manner as the rolled pieces before deſcribed. The pipes thus moulded require to be trimmed, that is, to have the prominences ariſing from the joining of the mould, and other ſuperfluous pieces of clay taken off, ſo as to render the ſurface ſmooth and round.

Trimming.—The operation of trimming is generally performed by boys and girls, as it requires very little ſkill. The trimmer has before him a ſmooth block of wood, about the length of the pipe, and of conſiderable thickneſs, elevated a little at the remote end. He has alſo a thick piece of ſmooth iron, one edge of which has acroſs it two or more ſemicylindrical grooves, capable of receiving half the ſhank of a pipe. Taking one of the rough moulded pipes, the trimmer carefully paſſes up the hollow of the ſhank, a wire ſimilar to that employed in moulding, and holding the pipe by the bole, while the ſhank lies before him on the wooden block, he pares off with a blunt knife all the excreſcences of clay, both from the ſhank and bole, and rubs the former, while lying on the block, with the grooved part of his iron, ſo as to render it as ſmooth as poſſible. He now cuts off the ragged piece at the extremity of the ſhank, withdraws the wire, and lays the pipe on the drying frame. One great object of the trimmer is, to ſee that the pipe is completely perforated, which he diſcovers by blowing through it; and if he finds the hole choked up, he muſt open it by puſhing the wire as far as poſſible. If this does not ſucceed, he breaks the pipe as uſeleſs.

Drying.—The pipe has now received all the work that can be beſtowed on it by the maker, previous to its being burned; but as the expoſing of it to heat, while ſoft and pliable, would make it crack, it is neceſſary that it be properly dried. For this purpoſe, a frame is prepared, compoſed of three or four long pieces of wood, faſtened to two end pieces in ſuch a manner, as that the middle of the frame ſhall be the loweſt, to give the ſhanks of the pipes that curve which they generally poſſeſs. After being trimmed, the pipes are laid beſide each other in this concave frame, with their boles hanging down over the edges of the frame, and their ſhanks bending within its hollow. In this poſition they are expoſed to the air till they are dry and firm. They are then ready for burning or baking.

Burning.—For burning or baking the pipes, there is to be prepared a kiln of a ſimple but peculiar conſtruction. It is built in the form of a cylinder, cloſe at the bottom and on the ſides, and open at the top. Below the bottom is a grate for receiving the fuel, and round the ſides are conſtructed vertical or ſpiral flues, opening at the top, and communicating below with the grate. The ſides of the furnace on its interior are pretty thin, and are formed of a cement compoſed of clay mixed with freſh cow dung. In the middle of the cavity is placed a pedeſtal compoſed of the ſame materials, for the pipes to lean againſt. When the pipes are ſufficiently dried, they are arranged round this pedeſtal, reſting againſt it, and againſt each other, with their boles next the bottom of the furnace. They are thus placed in ſucceſſive layers, till the furnace be ſufficiently full, when the open ſpace at top is filled up with bricks placed over each other, ſo as to leave interſtices for the free circulation of the air, and of the ſmoke and flame which iſſue through the flues. In theſe interſtices are laid ſeveral pieces of broken dried pipes, to ſerve as pyrometers for aſcertaining the ſtate of the included pipes during the burning. The fire is now lighted, and kept up, till, on examining the pieces of clay laid in the interſtices of the bricks, it is concluded that the pipes within the furnace are ſufficiently baked. The fire is then ſuffered to go out, and the whole to cool till the next day, when the bricks are taken down, the pipes removed, and packed in barrels for ſale.

After being burnt, the pipes are ſometimes glazed, which is done by rubbing them, while warm, with flannel and a little white wax. In ſome places the extremities of the ſhanks are rendered ſmooth by dipping them before burning in the ordinary potters glazing, which prevents that adheſion to the lips ſo unpleaſant in new unglazed pipes.

TOBAGO, one of the Caribbee iſlands, ceded to Great Britain by the treaty of Paris in 1763, taken by the French in 1781, and retaken by the Britiſh in 1793. It lies in the latitude of 11 degrees 10 minutes north, and 59 degrees 40 minutes longitude weſt from London, about 40 leagues ſouth-by-weſt from Barbadoes, 35 ſouth-eaſt from St Vincents, 20 ſouth-eaſt from Grenada, 12 north-eaſt from the Spaniſh iſland of Trinidada, and between 30 and 40 north-eaſt from the Spaniſh main. According to the lateſt accounts, it is ſomewhat more than 30 miles in length from north-eaſt to ſouth-weſt, between 8 and 9 in breadth, and from 23 to 25 leagues in circumference. The Engliſh viſited this iſland very early, Sir Robert Dudley being there in the reign of Queen Elizabeth. In that of Charles I. William earl of Pembroke procured a grant of this, with two other ſmall iſlands; but died before he was able to carry into execution his deſign of ſettling them. In A. D. 1632 ſome merchants of Zealand ſent over a ſmall colony thither, and gave it the name of *New Walcheren;* but before they were able thoroughly to eſtabliſh themſelves, they were deſtroyed by the Indians aſſiſted by the Spaniards. Ten years after, James duke of Courland ſent a colony thither, who ſettled themſelves upon Great Courland bay, and made a conſiderable progreſs in planting. A. D. 1654, Meſſieurs Adrian and Cornelius Lampſius, two opulent merchants of Fluſhing, ſent a conſiderable number of people thither, who ſettled on the other ſide of the iſland, and lived in amity with the Courlanders, until they learned that the king of Sweden had ſeized the perſon of their duke and diſpoſſeſſed him of his dominions, when they attacked and forced his ſubjects to ſubmit. The duke being afterwards reſtored, he obtained from Charles II. a grant of this iſland, dated the 17th of November 1664.

Tobago, Tobolſki.

1664. In the ſecond Dutch war the count d'Eſtrees, by order of his maſter, totally ruined it at the cloſe of the year 1677; and from that time it continued waſte till Britain took poſſeſſion of it after the treaty of Paris. The climate, notwithſtanding its vicinity to the line, is ſo tempered by the breezes from the ſea, as to be very ſupportable even to Europeans; and hath the ſame advantages with that of Grenada, in having regular ſeaſons, and alſo in being exempt from the hurricanes. There are throughout the iſland many riſing grounds, though, except at the north-eaſt extremity, there is no part of it that can be ſtyled mountainous; and even there the country is far from being rugged or impaſſable. The ſoil, if we may credit either Dutch or French writers, is as fertile and luxuriant as any of the iſlands, and very finely diverſified. Ground proviſions of all ſorts have been raiſed in great plenty, a vaſt variety of vegetables, excellent in their kind, ſome for food, ſome for phyſic. Almoſt every ſpecies of uſeful timber is to be found here, and ſome of an enormous ſize; amongſt others, the true cinnamon and nutmeg tree, as the Dutch confeſs, and of which none could be better judges; whole groves of ſaſſafras, and of trees that bear the true gum copal, with other odoriferous plants that render the air wholeſome and pleaſant. It is as well watered as can be wiſhed, by rivers that fall into the ſea on both ſides, many ſmaller ſtreams, and fine freſh ſprings in almoſt every part of the iſland. The ſea-coaſt is indented by 10 or 12 fair and ſpacious bays, and there are amongſt theſe one or two ports capable of receiving as large ſhips as ever viſited thoſe ſeas. There are wild hogs in great plenty, abundance of fowls of different kinds, and a vaſt variety of ſea and river fiſh. At the north-eaſt extremity lies Little Tobago, which is two miles long, and about half a mile broad, very capable of improvement.

TOBOLSKI, the capital of Siberia, is ſituated at the confluence of the rivers Tobol and Irtiſh, in N. Lat. 58° 12′, E. Long. 68° 18′. The city ſtands upon the aſcent of a high hill, the lower part of which is inhabited by Mahometan Tartars, who carry on a conſiderable traffic upon the river Irtiſh, and convey their merchandiſe quite acroſs Great Tartary, as far as China. The river Irtiſh is reckoned as rapid as the Danube; runs from the ſouth, and empties itſelf into the Oby: the Tobol waſhes the other ſide of the town, and a little below it falls into the Irtiſh. By means of theſe two rivers, there is a conſtant flow of merchandiſe into the city during the ſummer ſeaſon. Tobolſki is therefore a great mart for the commodities of Muſcovy, Tartary, and other countries: and here is a great concourſe of merchants. All ſorts of proviſions are plentiful and cheap. An hundred weight of rice is ſold for 16 copecs, equal to about eightpence ſterling; a ſturgeon weighing 40 pounds, for half that money; an ox for two rix-dollars, and every other article in proportion: the adjacent country abounds with game in great variety. The ſupreme court of judicature for all Siberia is held in this city, which is alſo the ſeat of a metropolitan, ſent hither from Moſcow to exerciſe ſpiritual juriſdiction over the whole kingdom. Tobolſki is well fortified, and defended by a ſtrong garriſon, under the command of the waiwode, who reſides in the place, and takes charge of the fur tribute, which is here depoſited in proper magazines. This governor enjoys a very extenſive command, and can occaſionally bring into the field 9000 men, beſides a ſtrong body of Tartars on horſeback, to make head againſt the Kalmucks and Coſſacks, in their repeated incurſions. A ſufficient number of Ruſſians, called *Jemſkoiks*, are kept in continual pay by the government, on the banks of the Irtiſh, to ſupply travellers on the czar's account with men, boats, or carriages, to convey them as far as Surgut on the Oby, a voyage of 200 leagues by water. This is the common method of travelling in the ſummer; but in winter the journey by land is not half ſo long, being performed in ſleds over the ice and ſnow, with which the country is covered. Theſe ſleds are moved by a pair of dogs, which will draw a load of 300 pounds with ſurpriſing expedition. They are hired at eaſy rates, and during one half of the year may be ſeen flying over the ſnow in great numbers. The city is ſuppoſed to contain 15,000 inhabitants. It is 800 miles eaſt from Moſcow, and 1000 from Peterſburgh.

Tobolſki, Tokay Wine.

TODDA PANNA. See CYCAS, BOTANY *Index*.

TODDY, a name given to the juice of the cocoa-nut tree. See ARACK.—Toddy is alſo a name given to a mixture of ſpirits, water, and ſugar.

TODDY-Bird. See LOXIA, ORNITHOLOGY *Index*.

TODUS, the TODY; a genus of birds belonging to the order of picæ. See ORNITHOLOGY *Index*.

TOGA, in Roman antiquity, a wide woollen gown or mantle, which ſeems to have been of a ſemicircular form, without ſleeves; differing both in richneſs and largeneſs, according to the circumſtances of the wearer, and uſed only upon occaſion of appearing in public.

Every body knows that the toga was the diſtinguiſhed mark of a Roman: hence, the *jus togæ*, or privilege of a Roman citizen; i. e. the right of wearing a Roman habit, and of taking, as they explain it, fire and water through the Roman empire.

TOKAY WINE, derives its name from a town of Hungary, where it is produced. There are four ſorts of wine made from the ſame grapes, diſtinguiſhed at Tokay by the names of *eſſence*, *auſpruch*, *maſslach*, and the *common wine*. The eſſence is made by picking out the half-dried and ſhrivelled grapes, and putting them into a perforated veſſel, where they remain as long as any juice runs off by the mere preſſure of their own weight. This is put into ſmall caſks. The auſpruch is made by pouring the expreſſed juice of the grapes from which the former had been picked on thoſe that yielded the eſſence, and treading them with the feet. The liquor thus obtained ſtands for a day or two to ferment, and then is poured into ſmall caſks, which are kept in the air for about a month, and afterwards put into caſks. The ſame proceſs is again repeated by the addition of more juice to the grapes which have already undergone the two former preſſures, and they are now wrung with the hands; and thus is had the maſslach. The fourth kind is made by taking all the grapes together at firſt, and ſubmitting them to the greateſt preſſure: this is chiefly prepared by the peaſants. The eſſence is thick, and very ſweet and luſcious: it is chiefly uſed to mix with the other kinds. The auſpruch is the wine commonly exported, and which is known in foreign countries by the name of *Tokay*.

The goodneſs of it is determined by the following rules. The colour ſhould neither be reddiſh nor very pale, but a light ſilver: in trying it, the palate and tip

of

of the tongue ſhould be wetted without ſwallowing it, and if it manifeſt any acrimony to the tongue it is not good; but the taſte ought to be ſoft and mild: when poured out, it ſhould form globules in the glaſs, and have an oily appearance: when genuine, the ſtrongeſt is always of the beſt quality: when ſwallowed, it ſhould have an earthy aſtringent taſte in the mouth, which is called the taſte of the root. All tokay wine has an aromatic taſte, which diſtinguiſhes it from every other ſpecies of wine. It keeps to any age, and improves by time: but is never good till about three years old. It is the beſt way to tranſport it in caſks; for when it is on the ſeas, it ferments three times every ſeaſon, and thus refines itſelf. When in bottles, there muſt be an empty ſpace left between the wine and the cork, otherwiſe it would burſt the bottle. A little oil is put upon the ſurface, and a piece of bladder tied over the cork. The bottles are always laid on their ſides in ſand. Phil. Tranſ. vol. lxiii. part ii. p. 292, &c.

TOKENS. See *TRADESMENS Tokens*.

TOISE, a French meaſure containing ſix of their feet, or a fathom.

TOLAND, JOHN, a famous writer, was born near Londonderry in Ireland in 1670, and educated in the Popiſh religion; but at 16 years of age embraced the principles of the Proteſtants. He ſtudied three years at the univerſity of Glaſgow; was created maſter of arts in the univerſity of Edinburgh; and afterwards completed his ſtudies at Leyden, where he reſided two years. He then went to Oxford, where, having the advantage of the public library, he collected materials upon various ſubjects, and compoſed ſome pieces; among which was, A Diſſertation to prove the received hiſtory of the tragical death of Atilius Regulus, the Roman conſul, to be a fable. He began likewiſe a work of greater conſequence, in which he undertook to ſhow that there are no myſteries in the Chriſtian religion. He publiſhed it in 1696 at London, under the title of *Chriſtianity not myſterious*. This book gave great offence, and was attacked by ſeveral writers. He afterward wrote in favour of the Hanoverian ſucceſſion, and many other pieces. In 1707 he went into Germany, where he viſited ſeveral courts; and in 1710 he was introduced to Prince Eugene, who gave him ſeveral marks of his generoſity. Upon his return to England he was for ſome time ſupported by the liberality of the earl of Oxford lord-treaſurer, and kept a country houſe at Epſom; but ſoon loſing his lordſhip's favour, he publiſhed ſeveral pamphlets againſt that miniſter's meaſures. In the laſt four years of his life he lived at Putney, but uſed to ſpend moſt part of the winter in London. Mr Toland died at London in 1722. He was a man of uncommon abilities, publiſhed a number of curious tracts, and was perhaps the moſt learned of all the infidel writers; but his private character was far from being an amiable one; for he was extremely vain, and wanted thoſe ſocial virtues which are the chief ornaments as well as duties of life. His poſthumous works, two volumes octavo, were publiſhed in 1726, with an account of his life and writings, by Mr Des Maizeaux.

Bourgoanne's Travel in Spain, vol. ii.

TOLEDO, an ancient and trading city of Spain in New Caſtile, of which it was formerly the capital. About two centuries ago it is ſaid to have contained more than 200,000 inhabitants; but they are now diminiſhed to 20,000, or at moſt to 30,000. It is advantageouſly ſeated on the river Tajo, which ſurrounds it on two ſides; and on the land ſide, it has an ancient wall built by a Gothic king, and flanked with 100 towers. It is ſeated on a mountain, which renders the ſtreets uneven, and which are narrow; but the houſes are fine, and there are a great number of ſuperb ſtructures, beſides 17 public ſquares, where the markets are kept. The fineſt buildings are the royal caſtle and the cathedral church; which laſt is the richeſt and moſt conſiderable in Spain. It is ſeated in the middle of the city, joining to a handſome ſtreet, with a fine ſquare before it. Several of the gates are very large, and of bronze. There is alſo a ſuperb ſteeple, extremely high, from whence there is a very diſtant proſpect. The Sagrariro, or principal chapel, is a real treaſury, in which are 15 large cabinets let into the wall, full of prodigious quantities of gold and ſilver veſſels, and other works. There are two mitres of ſilver gilt, ſet all over with pearls and precious ſtones, with three collars of maſſy gold, enriched in like manner. There are two bracelets and an imperial crown of the Virgin Mary, conſiſting of large diamonds and other jewels. The weight of the gold in the crown is 15 pounds. The veſſel which contains the conſecrated wafer is of ſilver gilt, as high as a man, and ſo heavy, that it requires 30 men to carry it; within it is another of pure gold enriched with jewels. Here are 38 religious houſes, moſt of which are worthy a traveller's notice, with many other ſacred buildings, a great number of churches belonging to 27 pariſhes, and ſome hoſpitals. Without the town are the remains of an amphitheatre, and other antiquities.

Swinburne's Travels in Spain.

Toledo is an archbiſhop's ſee, and the ſeat of the primate of Spain. His revenue is ſaid to be worth 400,000 ducats, but there are large deductions to be made from it. It pays 15,000 ducats to the monks of the Eſcurial, beſides ſeveral other penſions. Toledo has alſo a univerſity. It was formerly celebrated for the exquiſite temper of the ſword blades made there. It is ſituated in E. Long. 3. 15. N. Lat. 39. 50. and is 37 miles ſouth from Madrid.

TOLERATION, in matters of religion, is either civil or eccleſiaſtical. Civil toleration is an impunity and ſafety granted by the ſtate to every ſect that does not maintain doctrines inconſiſtent with the public peace: and eccleſiaſtical toleration is the allowance which the church grants to its members to differ in certain opinions, not reputed fundamental.

As the gods of Paganiſm were almoſt all local and tutelary, and as it was a maxim univerſally received that it was the duty of every man to worſhip, together with his own deities, the tutelary gods of the country in which he might chance to reſide, there was no room for perſecution in the Heathen world, on account of different ſentiments in religion, or of the different rites with which the various deities were worſhipped. Had the primitive Chriſtians joined their fellow-citizens in the worſhip of Jupiter, Juno, and the reſt of the rabble of Roman divinities, they would have been ſuffered to worſhip, without moleſtation, the Creator of the world and the Redeemer of mankind; for in that caſe the God of the Chriſtians would have been looked upon as a Being of the ſame kind with the gods of the empire; and the great principle of intercommunity would have remained unviolated. But the true God had expreſsly prohibited both Jews and Chriſtians from worſhipping any other god beſides Himſelf; and it was their refuſal to break that precept of their religion which made their Heathen maſters look upon them as Atheiſts, and perſecute them as a people inimical to the ſtate. Utility, and not truth, was the object for which the Heathen legiſlatures ſupported the national religion. They well knew that the ſtories told by their poets of their different divinities, of the rewards of Elyſium, and of the puniſhments of Tartarus, were a collection of ſenſeleſs fables; but they had nothing better to propoſe to the vulgar, and they were not ſuch ſtrangers to the human heart, as to ſuppoſe that mankind could live together in ſociety without being influenced in their conduct by ſome religion.

Widely different from the genius of Paganiſm was the ſpirit of the Jewiſh diſpenſation. Truth, which is in fact always coincident with general utility, was the great object of the Moſaic law. The children of Iſrael were ſeparated from the reſt of the world, to preſerve the knowledge and worſhip of the true God, at a time when all the other nations on earth, forgetting the Lord that made them, were falling proſtrate to ſtocks and ſtones, and worſhipping devils and impure ſpirits. Such was the contagion of idolatry, and ſo ſtrong the propenſity of the Iſraelites to the cuſtoms and manners of the Egyptians, and other polytheiſtic nations around them, that the purpoſe of their ſeparation could not have been ſerved, had not Jehovah condeſcended to become not only their tutelary God, but even their ſupreme civil Magiſtrate (ſee Theology, N° 151.); ſo that under the Moſaic economy, idolatry was the crime of high treaſon, and as ſuch juſtly puniſhed by the laws of the ſtate. Among the Jews, the church and ſtate were not indeed different ſocieties. They were ſo thoroughly incorporated, that what was a ſin in the one was a crime in the other; and the forfeiture of eccleſiaſtical privileges was the forfeiture of the rights of citizens.

In many reſpects the Chriſtian religion is directly oppoſite to the ritual law of Moſes. It is calculated for all nations, and intended to be propagated among all. Inſtead of ſeparating one people from another, one of its principal objects is to diſſeminate univerſal benevolence, and to inculcate upon the whole human race, that mutual love which naturally ſprings from the knowledge that all men are brethren. Its ultimate end being to train its votaries for heaven, it concerns itſelf no farther with the affairs of earth than to enforce by eternal ſanctions the laws of morality; and the kingdom of its Founder not being of this world, it leaves every nation at liberty to fabricate its own municipal laws, ſo as beſt to ſerve its own intereſt in the various circumſtances in which it may be placed; and denounces a curſe upon all who pay not to thoſe laws the fulleſt obedience, when they are not obviouſly inconſiſtent with the laws of piety and virtue, which are of prior obligation. The Chriſtian church therefore muſt always remain a diſtinct ſociety from the ſtate; and though, till the preſent age of hazardous innovations, it has been deemed expedient in every country, where the truth of the goſpel is admitted, to give to the religion of Chriſt a legal eſtabliſhment, and to confer immunities on its miniſters, this meaſure has been adopted, not to ſecure the purity of the faith, which appeals to the private judgement of each individual, but merely to preſerve the peace of ſociety, and to put a reſtraint upon thoſe actions of which human laws cannot take cognizance. With religion, Chriſtian governments have no farther concern than as it tends to promote the practice of virtue. The early Chriſtians, however, not underſtanding the principle upon which penal laws were employed to preſerve the purity of the Jewiſh religion; and, as our bleſſed Lord obſerved to two of his apoſtles, not knowing what ſpirit they were of—haſtily concluded that they had a right to enforce the doctrines and worſhip of the New Teſtament, by the ſame means which had been uſed to preſerve the Iſraelites ſteady to the doctrines and worſhip of the Old. Hence, though they had ſuffered the cruelleſt perſecutions themſelves (ſee Persecution), they no ſooner got the power of the ſtate in their hands, than they perſecuted the Pagans for their idolatry; and afterwards, when hereſies aroſe in the church, perſecuted one another for expreſſing in different phraſes metaphyſical propoſitions, of ſuch a nature as no human mind can fully comprehend. The apoſtle had forewarned them that there muſt be hereſies in the church, that they who are approved may be made manifeſt; but it did not occur to them that perſecution for opinion is the worſt of all hereſies, as it violates at once truth and charity.

Hitherto theſe unhallowed means of bringing Chriſtians to uniformity of faith and practice, had been only occaſionally employed, from their not accurately diſtinguiſhing between the ſpirit of the goſpel and that of the law; but as ſoon as the biſhops of Rome had brought the inhabitants of Europe to recognize their infallibility in explaining articles of faith and deciding points of controverſy, perſecution became a regular and permanent inſtrument of eccleſiaſtical diſcipline. To doubt or to deny any doctrine to which theſe unerring inſtructors had given the ſanction of their approbation, was held to be not only a reſiſting of the truth, but an act of rebellion againſt their ſacred authority; and the ſecular power, of which, by various arts, they had acquired the abſolute direction, was inſtantly employed to avenge both.

Robertſon's Hiſtory of Charles V.

"Thus Europe had been accuſtomed, during many centuries, to ſee ſpeculative opinions propagated or defended by force; the charity and mutual forbearance which Chriſtianity recommends with ſo much warmth, were forgotten, the ſacred rights of conſcience and of private judgement were unheard of, and not only the idea of toleration, but even the word itſelf, in the ſenſe now affixed to it, was unknown. A right to extirpate error by force, was univerſally allowed to be the prerogative of thoſe who poſſeſſed the knowledge of truth; and though the firſt reformers did not arrogate to themſelves in direct terms that infallibility which they had refuſed to the church of Rome, they were not leſs confident of the truth of their own doctrines, and required with equal ardour the princes of their party to check ſuch as preſumed to impugn or to oppoſe them. To this requeſt too many of theſe princes lent a willing ear. It flattered at once their piety and their pride to be conſidered as poſſeſſing all the rights of Jewiſh princes; and Henry the VIII. of England, after labouring to make his divines declare that all authority eccleſiaſtical as well as civil flows from the crown, perſecuted alternately the Papiſts and Proteſtants. Many of his ſucceſſors, whoſe characters were much better than his, thought themſelves duly authorized, in virtue of their acknowledged ſupremacy over all ſtates and conditions of men, to enforce by means of penal laws a uniformity of faith and worſhip among their ſubjects: and it was not till the revolution that any ſect in England ſeems to have fully underſtood, that all men have an unalienable right to worſhip God in the manner which to them may ſeem moſt ſuitable to his nature, and the relation in which they ſtand to him; or that it is impoſſible to produce uniformity of opinion by any other means than candid diſquiſition and ſound reaſoning. That the civil magiſtrate has a right to check the propagation of opinions which tend only to ſap the foundations of virtue, and to diſturb the peace of ſociety, cannot, we think, be queſtioned; but that he has no right to reſtrain mankind from publicly profeſſing any ſyſtem of faith, which comprehends the being and providence of God, the great laws of morality, and a future ſtate of rewards and puniſhments, is as evident as that it is the object of religion to fit mankind for heaven, and the whole duty of the magiſtrates to maintain peace, liberty, and property, upon earth. We have elſewhere obſerved (ſee Test), that among a number of different ſects of Chriſtians, it is not the ſuperior purity of the ſyſtem of faith profeſſed by one of them, that gives it a right to the immunities of an eſtabliſhment in preference to all its rivals; but though the legiſlature is authorized, in certain circumſtances, to make a leſs pure ſyſtem the religion of the ſtate, it would be the height of abſurdity to ſuppoſe that any man, or body of men, can have authority to prevent a purer ſyſtem from being acknowledged as the religion of individuals. For propagating opinions and purſuing practices which neceſſarily create civil diſturbance, every man is anſwerable to the laws of his country; but for the ſoundneſs of his faith, and the purity of his worſhip, he is anſwerable to no tribunal but that which can ſearch the heart.

When churches are eſtabliſhed, and creeds drawn up as guides to the preaching of the national clergy, it is obvious that every clergyman who teaches any thing directly contrary to the doctrine of ſuch creeds, violates the condition on which he holds his living, and may be juſtly deprived of that living, whether his obnoxious opinion be in itſelf true or falſe, important or unimportant; but his puniſhment ſhould be extended no farther. To expel a Chriſtian from private communion for teaching any doctrine which is neither injurious to the ſtate nor contrary to the few ſimple articles which compriſe the ſum of the Chriſtian faith, is the groſſeſt tyranny; and the governors of that church which is guilty of it, uſurp the prerogative of the bleſſed Lord, who commanded the apoſtles themſelves not to be called maſters in this ſenſe; for one (ſays he) is your maſter (υμων ὁ καθηγητης), even Chriſt. It is indeed a hardſhip to deprive a man of his living for conſcientiouſly illuſtrating what he believes to be a truth of the goſpel, only becauſe his illuſtration may be different from that which had formerly been given by men fallible like himſelf; but if the eſtabliſhment of human compilations of faith be neceſſary, this hardſhip cannot be removed, but by making ſuch compilations as ſimple as poſſible, and drawing them up in ſcripture language. Such a reformation, could it be effected peaceably, would ſerve other good purpoſes; for while it would ſufficiently guard the purity of the faith, it would withdraw that temptation which too many eſtabliſhments throw in the way of men, to ſubſcribe to the truth of what they do not really believe; and it would effectually baniſh from the Chriſtian church every thing which can be called by the name of *perſecution*. See Nonconformists.

TOLL, a tax or cuſtom paid for liberty to vend goods in a market or fair, or for keeping roads in proper repair. The firſt appointment of a toll on highways of which we read, took place in 1346. See Road.

TOLOUSE. See Toulouse.

TOLU, a town of South America in Terra Firma, and in the government of Carthagena; famous for the fine balſam of Tolu, brought into Europe from thence, and produced from a tree like a pine. It is ſeated on a bay of the North ſea, 60 miles ſouth of Carthagena. W. Long. 72. 55. N. Lat. 9. 40.

TOLUIFERA, the Balsam-of-Tolu tree; a genus of plants belonging to the claſs of decandria. See Botany, p. 182. and Chemistry, N° 2483.

TOMATOES. See Solanum, Botany *Index*.

TOMB, includes both the grave or ſepulchre wherein a defunct is interred, and the monument erected to preſerve his memory. The word is formed from the Greek τυμβος, *tumulus*, "ſepulchre;" or, according to Menage, from the Latin *tumba*, which ſignifies the ſame.

In many nations it has been cuſtomary to burn the bodies of the dead, and to collect the aſhes with pious care into an urn, which was depoſited in a tomb or ſepulchre. See Burning. Among many nations it has alſo been the practice to lay the dead body in a tomb, without conſuming it, after having wrapped it up decently, and ſometimes placing it in a coffin. See Coffin.

The tombs of the Jews were generally hollow places hewn out of a rock. Abraham buried Sarah in a cave. Such was the place too in which the kings of Judah and Iſrael were interred: and ſuch was the place in which the body of our Saviour was depoſited by Joſeph of Arimathea. But it is probable that the common people buried their dead in graves; for our Saviour compares the Phariſees to "graves which appear not, and the men that walk over them are not aware of them." Over the tombs, perhaps only of people of diſtinction, a ſtone or monument was erected, to intimate to paſſengers that they were burying places, that they might not pollute themſelves by touching them. With the ſame intention, as Lightfoot informs us, they whitened them every year on the 15th of February.

The Egyptians alſo buried their dead in caves, called *catacombs*. See Catacomb. The pyramids, as ſome think, were alſo employed for the ſame purpoſe. Sometimes alſo, after embalming their dead, they placed them in niches in ſome magnificent apartment in their houſes.

The Greeks and Romans burned their dead, and depoſited their aſhes in a tomb. The Greeks interred the aſhes without the cities, by the ſides of their highways. Sometimes indeed, by way of particular honour, they were buried in an elevated part of the town; and the Lacedemonians were allowed by Lycurgus to bury in the city and round their temples: But this was forbidden among the Romans by the law of the twelve tables, *In urbe ne ſepelito, neve urito*; yet Valerius Publicola, Poſthumus Tubertius, and the family of the Claudii, were buried in the Capitol. To bury by the ſides of public

public roads was common among the Romans alſo; hence their epitaphs frequently began with *ſiſte viator.* Highways were made choice of probably for two reaſons: 1. That the dead might not be offenſive or injure the health of the living, which they certainly would if buried in towns or populous places; and, 2dly, That they might hold out to travellers a leſſon of mortality, and teach the ruſtic moraliſt to die.

As it would ſwell this article to too great a ſize to deſcribe all the different kinds of tombs which have been uſed by different nations and ages, we muſt content ourſelves with ſhortly deſcribing the tombs of a few nations, and adding a few concomitant circumſtances.

The tombs of the Parſees are ſingular. The deceaſed, after lying a proper time in his own houſe, for the purpoſes of mourning, is carried, followed by his relations and friends, the females chanting a requiem, and depoſited in a tomb of the following conſtruction. It is a circular building, open at top, about 55 feet diameter, and 25 feet in height, filled to within 5 feet of the top, excepting a well of 15 feet diameter in the centre. The part ſo filled is terraced, with a ſlight declivity toward the well. Two circular grooves three inches deep are raiſed round the well; the firſt at the diſtance of four, the ſecond at ten, feet from the well. Grooves of the like depth or height, and four feet diſtant from each other at the outer part of the outer circle, are carried ſtraight from the wall to the well, communicating with the circular ones, for the purpoſe of carrying off the water, &c. The tomb, by this means, is divided into three circles of partitions: the outer, about ſeven feet by four: the middle ſix by three: the inner, four by two: the outer for the men, the middle for the women, the inner for the children; in which the bodies are reſpectively placed, wrapped looſely in a piece of cloth, and left to be devoured by the vultures; which is very ſoon done, as numbers of thoſe animals are always ſeen hovering and watching about theſe charnel houſes, in expectation of their prey. The friends of the deceaſed, or the perſons who have charge of the tomb, come at the proper time, and throw the bones into their receptacle, the well in the centre; for which purpoſe, iron rakes and tongs are depoſited in the tomb. The entrance is cloſed by an iron door, four feet ſquare, on the eaſtern ſide, as high up as the terrace, to which a road is raiſed. Upon the wall, above the door, an additional wall is raiſed, to prevent people from looking into the tomb, which the Parſees are particularly careful to prevent. A Perſian inſcription is on a ſtone inſerted over the door, which we once copied, but have forgotten its tenor. From the bottom of the wall ſubterraneous paſſages lead to receive the bones, &c. and prevent the well from filling.

Archæologia, vol. vii.

Of the ancient ſepulchres found in Ruſſia and Siberia, ſome are perfect tumuli, raiſed to an enormous height, while others are almoſt level with the ground. Some of them are encompaſſed with a ſquare wall of large quarry ſtones placed in an erect poſition; others are covered only with a ſmall heap of ſtones, or they are tumuli adorned with ſtones at top. Some are walled with brick within, and vaulted over; others are no more than pits or common graves. In ſome the earth is excavated ſeveral fathoms deep; others, and eſpecially thoſe which are topped by a lofty tumulus, are only dug of a ſufficient depth for covering the carcaſe. In many of theſe ſepulchres the bones of men, and frequently of horſes, are found, and in a condition that renders it probable the bodies were not burnt before they were inhumed. Other bones ſhow clearly that they have been previouſly burnt; becauſe a part of them is unconſumed, and becauſe they lie in a diſordered manner, and ſome of them are wanting. Urns, in which other nations of antiquity have depoſited the aſhes of their dead, are never met with here. But ſometimes what remained of their bodies after the combuſtion, and even whole carcaſes, are found wrapped up in thin plates of gold. Many dead bodies are frequently ſeen depoſited together in one tomb; a certain indication that either a battle had been fought in the neighbourhood of the place, or that ſome families buried their relations in an hereditary tomb.

Chenier's Morocco, vol. i.

The Moors, like all other Mahometans, hold it a thing irreverent, and contrary to the ſpirit of religion, to bury their dead in moſques, and to profane the temple of the Moſt High by the putrefaction of dead bodies. In the infancy of the church the Chriſtians had the like piety, and gave example of the reſpect in which they held temples dedicated to religious worſhip; but ill-guided devotion, mingled with ſuperſtitious vanities, and that contagious ſpirit of ſelf-intereſt which pervades all human affairs, without reſpecting the altar of God, have, together, inſenſibly perverted men's ideas. The burial grounds of the Mahometans are moſt of them without the city; the emperors have their ſepulchres diſtinct and diſtant from the moſque, in ſanctuaries, built by themſelves, or in places which they have indicated: their tombs are exceedingly ſimple; the Moors do not imitate the oſtentation of Europeans, where ſuperb monuments are raiſed rather to gratify the pride of the living than the merit of the dead.

All Mahometans inter the dead at the hour ſet apart for prayer. The defunct is not kept in the houſe, except he expires after ſunſet; but the body is tranſported to the moſque, whither it is carried by thoſe who are going to prayer. Each, from a ſpirit of devotion, is deſirous to carry in his turn. The Moors ſing at their burial ſervice; which uſage perhaps they have imitated after the Chriſtians of Spain, for the oriental Mahometans do not ſing. They have no particular colour appropriated to mourning; their grief for the loſs of relations is a ſenſation of the heart they do not attempt to expreſs by outward ſymbols. Women regularly go on the Friday to weep over and pray at the ſepulchres of the dead, whoſe memory they hold dear.

Among the northern nations it was cuſtomary to bury their dead under heaps of ſtones called *cairns*, or under barrows: (See the articles CAIRNS and BARROW). The inhabitants of Tibet, it is ſaid, neither bury nor burn their dead, but expoſe them on the tops of mountains. See TIBET.

TOMPION; a ſort of bung or cork uſed to ſtop the mouth of a cannon. At ſea this is carefully encircled with tallow or putty, to prevent the penetration of the water into the bore, whereby the powder contained in the chamber might be damaged or rendered incapable of ſervice.

TON, a meaſure or weight. See TUN.

TONE, or TUNE, in *Muſic*, a property of ſound, whereby it comes under the relation of *grave* and *acute*;

or the degree of elevation any ſound has, from the degree of ſwiftneſs of the vibrations of the parts of the ſonorous body.

The variety of tones in human voices ariſes partly from the dimenſions of the windpipe, which, like a flute, the longer and narrower it is, the ſharper the tone it gives; but principally from the head of the larynx or knot of the throat: the tone of the voice being more or leſs grave as the rima or cleft thereof is more or leſs open.

The word *tone* is taken in four different ſenſes among the ancients: 1. For any ſound; 2. For a certain interval, as when it is ſaid the difference between the diapente and diateſſaron is a tone; 3. For a certain locus or compaſs of the voice, in which ſenſe they uſed the Dorian, Phrygian, Lydian tones; 4. For tenſion, as when they ſpeak of an acute, grave, or a middle tone.

Tone is more particularly uſed, in muſic, for a certain degree or interval of tune, whereby a ſound may be either raiſed or lowered from one extreme of a concord to the other, ſo as ſtill to produce true melody.

TONGUE. See Anatomy, N° 102.

TONIC, in *Muſic*, ſignifies a certain degree of tenſion, or the ſound produced by a vocal ſtring in a given degree of tenſion, or by any ſonorous body when put in vibration.

Tonic, ſays Rouſſeau, is likewiſe the name given by Ariſtoxenus to one of the three kinds of chromatic muſic, whoſe diviſions he explains, and which was the ordinary chromatic of the Greeks, proceeding by two ſemitones in ſucceſſion, and afterwards a third minor.

Tonic Dominant. See Dominant.

TONNAGE *and* Poundage, an ancient duty on wine and other goods, the origin of which ſeems to have been this: About the 21ſt of Edward III. complaint was made that merchants were robbed and murdered on the ſeas. The king thereupon, with the conſent of the peers, levied a duty of 2s. on every ton of wine, and 12d. in the pound on all goods imported; which was treated as illegal by the commons. About 25 years after, the king, when the knights of ſhires were returned home, obtained a like grant from the citizens and burgeſſes, and the year after it was regularly granted in parliament. Theſe duties were diminiſhed ſometimes, and ſometimes increaſed; at length they ſeem to have been fixed at 3s. tonnage and 1s. poundage. They were at firſt uſually granted only for a ſtated term of years, as, for two years in 5 Ric. II.; but in Henry VI.'s time they were granted him for life by a ſtatute in the 31ſt year of his reign; and again to Edward IV. for the term of his life alſo: ſince which time they were regularly granted to all his ſucceſſors for life, ſometimes at the firſt, ſometimes at other ſubſequent parliaments, till the reign of Charles I.; when, as the noble hiſtorian expreſſes it, his miniſters were not ſufficiently ſolicitous for a renewal of his legal grant. And yet theſe impoſts were imprudently and unconſtitutionally levied and taken, without conſent of parliament, for 15 years together; which was one of the cauſes of thoſe unhappy diſcontents, juſtifiable at firſt in too many inſtances, but which degenerated at laſt into cauſeleſs rebellion and murder. For, as in every other, ſo in this particular caſe, the king (previous to the commencement of hoſtilities) gave the nation ample ſatisfaction for the errors of his former conduct, by paſſing an act, whereby he renounced all power in the crown of levying the duty of tonnage and poundage, without the expreſs conſent of parliament; and alſo all power of impoſition upon any merchandiſes whatever. Upon the reſtoration this duty was granted to King Charles II. for life, and ſo it was to his two immediate ſucceſſors; but now, by three ſeveral ſtatutes, 9 Ann. c. 6. 1 Geo. I. c. 12. and 3 Geo. I. c. 7. it is made perpetual, and mortgaged for the debt of the public.

Blackſt. Comment. vol. i.

TONQUIN, a kingdom of Aſia, in the Eaſt Indies, beyond the Ganges; bounded on the north by the province of Yunnan in China, on the eaſt by the province of Canton and the bay of Tonquin, on the ſouth by Cochin China, and on the weſt by the kingdom of Laos. It is about 1200 miles in length and 500 in breadth; and is one of the fineſt and moſt conſiderable kingdoms of the Eaſt, as well on account of the number of inhabitants as the riches it contains and the trade it carries on. The country is thick ſet with villages; and the natives in general are of a middle ſtature and clean limbed, with a tawny complexion. Their faces are oval and flattiſh, and their noſes and lips well proportioned. Their hair is black, long, lank, and coarſe; and they let it hang down their ſhoulders. They are generally dexterous, nimble, active, and ingenious in mechanic arts. They weave a multitude of fine ſilks, and make curious lacker-works, which are tranſported to other countries. There is ſuch a number of people, that many want employment; for they ſeldom go to work but when foreign ſhips arrive. The money and goods brought hither by the Engliſh and Dutch put them in action; for they have not money of their own ſufficient to employ themſelves; and therefore one-third at leaſt muſt be advanced beforehand by the merchants: and the ſhips muſt ſtay here till the goods are finiſhed, which is generally five or ſix months. They are ſo addicted to gaming, that when every thing elſe is loſt, they will ſtake their wives and children. The garments of the Tonquineſe are made either of ſilk or cotton; but the poor people and ſoldiers wear only cotton of a dark tawny colour. Their houſes are ſmall and low; and the walls either of mud, or hurdles daubed over with clay. They have only a ground floor, with two or three partitions; and each room has a ſquare hole to let in the light. The villages conſiſt of 30 or 40 houſes, ſurrounded with trees; and in ſome places there are banks to keep the water from overflowing their gardens, where they have oranges, betels, melons, and ſalad-herbs. In the rainy ſeaſon they cannot paſs from one houſe to another without wading through the water; they ſometimes have boats. In the capital city called *Cacho* there are about 20,000 houſes with mud-walls, and covered with thatch; a few are built with brick, and roofed with pan-tiles. In each yard is a ſmall arched building like an oven, about ſix feet high, made of brick, which ſerves to ſecure their goods in caſe of fire. The principal ſtreets are very wide, and paved with ſmall ſtones. The king of Tonquin has three palaces in it, ſuch as they are; and near them are ſtables for his horſes and elephants. The houſe of the Engliſh factory is ſeated at the north end of the city, fronting the river, and is the beſt in the city. The people in general are courteous, and civil to ſtrangers; but the great men are proud, haughty, and ambitious; the ſoldiers inſolent, and the poor thieviſh. They buy all their

their wives, of which the great men have ſeveral; but the poor are ſtinted for want of money. In hard times the men will ſell both their wives and children to buy rice to maintain themſelves. The women offer themſelves to ſtrangers as wives while they ſtay, and agree with them for a certain price. Even the great men will offer their daughters to the merchants and officers who are likely to ſtay ſix months in the country. They are not afraid of being with child; for if they are girls they can ſell them well when they are young, becauſe they are fairer than the other inhabitants. Theſe women are ſaid to be very faithful; and are truſted with money and goods by the Europeans during their abſence, and will make great advantage with them. The firſt new moon in the year that happens after the middle of January, is a great feſtival; when they rejoice for 10 or 12 days together, and ſpend their time in all manner of ſports. Their common drink is tea, but they make themſelves merry with arrack. The language is ſpoken very much in the throat; and ſome of the words are pronounced through the teeth, and has a great reſemblance to the Chineſe. They have ſeveral mechanic arts or trades; ſuch as ſmiths, carpenters, joiners, turners, weavers, taylors, potters, painters, money-changers, paper-makers, workers in lacker, and bell-founders.—Their commodities are gold, muſk, ſilks, calicoes, drugs of many ſorts, woods for dyeing, lacquered wares, earthen wares, ſalt, aniſeeds, and worm-ſeeds. The lacquered ware is not inferior to that of Japan, which is accounted the beſt in the world. With all theſe merchandiſes, one would expect the people to be very rich, but they are in general very poor; the chief trade being carried on by the Chineſe, Engliſh, and Dutch. The goods imported, beſides ſilver, are ſaltpetre, ſulphur, Engliſh broad-cloth, pepper, ſpices, and great guns.

TONSILS. See ANATOMY, N° 102.

TONSURE, in *Eccleſiaſtical Hiſtory*, a particular manner of ſhaving or clipping the hair of eccleſiaſtics or monks. The ancient tonſure of the clergy was nothing more than polling the head, and cutting the hair to a moderate degree, for the ſake of decency and gravity: and the ſame obſervation is true with reſpect to the tonſure of the ancient monks. But the Romans have carried the affair of tonſure much farther; the candidate for it kneeling before the biſhop, who cuts the hair in five different parts of the head, viz. before, behind, on each ſide, and on the crown.

TONTINE, a loan given for life annuities with benefit of ſurvivorſhip; ſo called from the inventor Laurence Tonti, a Neapolitan. He propoſed his ſcheme in 1653 to reconcile the people to Cardinal Mazarine's government, by amuſing them with the hope of becoming ſuddenly rich. He obtained the conſent of the court, but the parliament would not regiſter the edict. He made attempts afterwards, but without ſucceſs.

It was not till Louis XIV. was diſtreſſed by the league of Augſburg, and by his own immenſe expences, that he had recourſe to the plans of Tonti, which, though long laid aſide, were not forgotten. By an edict in 1689 he created a Tontine royale of 1,400,000 livres annual rent, divided into 14 claſſes. The actions were 300 livres a piece, and the proprietors were to receive 10l. per cent. with benefit of ſurvivorſhip in every claſs. This ſcheme was executed but very imperfectly; for none of the claſſes roſe to above 25,000 livres, inſtead of 100,000, according to the original inſtitution; though the annuities were very regularly paid. A few years after, the people ſeeming in better humour for projects of this kind, another tontine was erected upon nearly the ſame terms, but this was never above half full. They both ſubſiſted in the year 1726, when the French king united the 13th claſs of the firſt tontine with the 14th of the ſecond; all the actions of which were poſſeſſed by Charlotte Bonnemay, widow of Lewis Barbier, a ſurgeon of Paris, who died at the age of 96. This gentlewoman had ventured 300 livres in each tontine; and in the laſt year of her life ſhe had for her annuity 73,500 livres, or about 3600l. a-year, for about 30l.

The nature of the tontine is this; there is an annuity, after a certain rate of intereſt, granted to a number of people; divided into claſſes, according to their reſpective ages; ſo that annually the whole fund of each claſs is divided among the ſurvivors of that claſs; till at laſt it falls to one, and upon the extinction of that life, reverts to the power by which the tontine was erected, and which becomes thereby ſecurity for the due payment of the annuities.

TOOL, among mechanics, denotes in general any inſtrument uſed for making other complex inſtruments and machines, or in other operations of the mechanic arts.

TOOTH, for a deſcription of, ſee ANATOMY, N° 27.

TOOTHACH. See MEDICINE, N° 210, and SURGERY *Index*.

Toothach-Tree. See ZANTHOXYLUM, } BOTANY
TOOTHWORT. See PLUMBAGO, } *Index*.

TOP, a ſort of platform, ſurrounding the lower maſthead, from which it projects on all ſides like a ſcaffold.

The principal intention of the top is to extend the topmaſt ſhrouds, ſo as to form a greater angle with the maſt, and thereby give additional ſupport to the latter. It is ſuſtained by certain timbers fixed acroſs the hounds or ſhoulders of the maſts, and called the *treſtle-trees* and *croſs-trees*.

Beſides the uſe above-mentioned, the top is otherwiſe extremely convenient to contain the materials neceſſary for extending the ſmall ſails, and for fixing or repairing the rigging and machinery with more facility and expedition. In ſhips of war it is uſed as a kind of redoubt, and is accordingly fortified for attack or defence; being furniſhed with ſwivels, muſketry, and other fire-arms, and guarded by a thick fence of corded hammocks. Finally, it is employed as a place for looking out, either in the day or night.

Top-Maſt, the ſecond diviſion of a maſt, or that part which ſtands between the upper and lower pieces. See the article MAST.

Top-Sails, certain large ſails extended acroſs the topmaſts by the topſail-yard above, and by the yard attached to the lower maſt beneath; being faſtened to the former by robands, and to the latter by means of two great blocks fixed on its extremities, through which the topſail-ſheets are inſerted, paſſing from thence to two other blocks fixed on the inner part of the yard cloſe by the maſt; and from theſe latter the ſheets lead downwards to the deck, where they may be ſlackened or extended at pleaſure. See the article SAIL.

TOPAZ, a gem or precious ſtone. See MINERALOGY *Index*.

TOPE, a ſpecies of SQUALUS. See ICHTHYOLOGY *Index*.

TOPHET. See HINNOM and MOLOCH.

TOPHUS, in *Medicine*, denotes a chalky or ſtony concretion in any part of the body; as the bladder, kidney, &c. but eſpecially in the joints.

TOPIC, a general head or ſubject of diſcourſe.

TOPICS, in *Oratory*. See ORATORY, N° 10—13.

TOPICS, or *Topical Medicines*, are the ſame with external remedies, or thoſe applied outwardly to ſome diſeaſed and painful part: ſuch are plaſters, cataplaſms, unguents, &c.

TOPOGRAPHY, a deſcription or draught of ſome particular place, or ſmall tract of land, as that of a city or town, manor, or tenement, field, garden, houſe, caſtle, or the like; ſuch as ſurveyors ſet out in their plots, or make draughts of, for the information and ſatisfaction of the proprietors.

TOPSHAM, a town in Devonſhire, in England, ſeated on the river Exmouth, five miles ſouth-eaſt of Exeter, to which place the river was formerly navigable; but in time of war was choaked up deſignedly, ſo that ſhips are now obliged to load and unload at Topſham. W. Long. 3. 26. N. Lat. 50. 39.

TORBAY, a fine bay of the Engliſh channel, on the coaſt of Devonſhire, a little to the eaſt of Dartmouth, formed by two capes, called *Bury Points*, and *Bob's Noſe*.

TORDA, or RASOR-BILL. See ALCA, ORNITHOLOGY *Index*.

TORDYLIUM, HART-WORT, a genus of plants belonging to the claſs of pentandria, and in the natural ſyſtem arranged under the 45th order, *Umbellatæ*. See BOTANY *Index*.

TORIES, a political faction in Britain, oppoſed to the Whigs.

The name of *Tories* was given to a ſort of banditti in Ireland, and was thence transferred to the adherents of Charles I. by his enemies, under the pretence that he favoured the rebels in Ireland. His partiſans, to be even with the republicans, gave them the name of *Whigs*, from a word which ſignifies *whey*, in deriſion of their poor fare. The Tories, or *cavaliers*, as they were alſo called, had then principally in view the political intereſt of the king, the crown, and the church of England; and the round-heads, or Whigs, propoſed chiefly the maintaining of the rights and intereſts of the people, and of Proteſtantiſm. This is the moſt popular account; and yet it is certain the names *Whig* and *Tory* were but little known till about the middle of the reign of King Charles II. M. de Cize relates, that it was in the year 1678 that the whole nation was firſt obſerved to be divided into Whigs and Tories; and that on occaſion of the famous depoſition of Titus Oates, who accuſed the Catholics of having conſpired againſt the king and the ſtate, the appellation of *Whig* was given to ſuch as believed the plot real; and *Tory* to thoſe who held it fictitious.

Theſe parties may be conſidered either with regard to the ſtate or to religion. The ſtate Tories are either violent or moderate: the firſt would have the king to be abſolute, and therefore plead for paſſive obedience, non-reſiſtance, and the hereditary right of the houſe of Stuart. The moderate Tories would not ſuffer the king to loſe any of his prerogative; but then they would not ſacrifice thoſe of the people. The ſtate Whigs are either ſtrong repuplicans or moderate ones. The firſt (ſays Rapin) are the remains of the party of the long parliament, who attempted to change monarchy to a commonwealth: but theſe make ſo ſlender a figure, that they only ſerved to ſtrengthen the party of other Whigs. The Tories would perſuade the world, that all the Whigs are of this kind; as the Whigs would make us believe that all the Tories are violent. The moderate ſtate Whigs are much in the ſame ſentiments with the moderate Tories, and deſire that the government may be maintained on the ancient foundation: all the difference is, that the firſt bear a little more to the parliament and people, and the latter to that of the king. In ſhort, the old Whigs were always jealous of the encroachments of the royal prerogative, and watchful over the preſervation of the liberties and properties of the people.

TORMENTILLA, TORMENTIL, a genus of plants belonging to the claſs of *icoſandria*, and in the natural ſyſtem ranging under the 35th order, *Senticoſæ*. See BOTANY *Index*.

TORNADO, a ſudden and vehement guſt of wind from all points of the compaſs, frequent on the coaſt of Guinea.

TORPEDO, the CRAMP-FISH. See RAJA, ICHTHYOLOGY *Index*.

TORPOR, a numbneſs, or defect of feeling and motion. Galen ſays it is a ſort of intermediate diſorder between palſy and health.

TORREFACTION, in *Chemiſtry*, is the roaſting or ſcorching of a body by the fire, in order to diſcharge a part either unneceſſary or hurtful in another operation. Sulphur is thus diſcharged from an ore before it can be wrought to advantage.

TORRENT, denotes a temporary ſtream of water falling ſuddenly from mountains, whereon there have been great rains, or an extraordinary thaw of ſnow.

TORRICELLI, EVANGELISTE, an illuſtrous Italian mathematician and philoſopher, born at Faenza in 1608. He was trained in Latin literature by his uncle a monk; and after cultivating mathematical knowledge for ſome time without a maſter, he ſtudied it under Father Benedict Caſtelli, profeſſor of mathematics at Rome. Having read Galileo's dialogues, he compoſed a treatiſe on motion, on his principles, which brought him acquainted with Galileo, who took him home as an aſſiſtant: but Galileo died in three months after. He became profeſſor of mathematics at Florence, and greatly improved the art of making teleſcopes and microſcopes: but he is beſt known for finding out a method of aſcertaining the weight of the atmoſphere by quickſilver; the barometer being called, from him, the *Torricellian tube*. He publiſhed *Opera Geometrica*, 4to, 1644; and died in 1647.

TORRICELLIAN EXPERIMENT, a famous experiment made by Torricelli, by which he demonſtrated the preſſure of the atmoſphere in oppoſition to the doctrines of ſuction, &c. finding that preſſure able to ſupport only a certain length of mercury, or any other fluid, in an inverted glaſs tube. See BAROMETER.

TORSK, or TUSK. See GADUS, ICHTHYOLOGY *Index*.

TORTOISE. See TESTUDO, ERPETOLOGY *Index*.

Phil. Tranſ. N° 438. p. 117.

TORTOISE-ſhell, the ſhell, or rather ſcales, of the teſtaceous animal called a *tortoiſe;* uſed in inlaying, and in various other works, as for ſnuff-boxes, combs, &c. Mr Cateſby obſerves, that the hard ſtrong covering which incloſes all ſorts of tortoiſes, is very improperly called a *ſhell;* being of a perfect bony contexture; but covered on the outſide with ſcales, or rather plates, of a horny ſubſtance; which are what the workmen call *tortoiſe-ſhell.*

There are two general kinds of tortoiſes, viz. the *land* and *ſea tortoiſe*, *teſtudo terreſtris* and *marina*. The ſea-tortoiſe, again, is of ſeveral kinds; but it is the caret, or teſtudo imbricata of Linnæus, alone which furniſhes that beautiful ſhell ſo much admired in Europe.

The ſhell of the caretta, or hawkſbill tortoiſe, is thick; and conſiſts of two parts, the upper, which covers the back, and the lower the belly: the two are joined together at the ſides by ſtrong ligaments, which yet allow of a little motion. In the fort-part is an aperture for the head and fore-legs, and behind for the hind-legs and tail. It is the under ſhell alone that is uſed: to ſeparate it, they make a little fire beneath it, and as ſoon as ever it is warm, the under ſhell becomes eaſily ſeparable with a point of a knife, and is taken off in laminæ or leaves.

The whole ſpoils of the caret conſiſt in 13 leaves or ſcales, eight of them flat, and five a little bent. Of the flat ones, there are four large ones, ſometimes a foot long, and ſeven inches broad. The beſt tortoiſe-ſhell is thick, clear, tranſparent, of the colour of antimony, ſprinkled with brown and white. When uſed in marquetry, &c. the workmen give it what colour they pleaſe by means of coloured leaves, which they put underneath it.

Working and joining of TORTOISE-*ſhell.*—Tortoiſe-ſhell and horn become ſoft in a moderate heat, as that of boiling water, ſo as to be preſſed, in a mould, into any form, the ſhell or horn being previouſly cut into plates of a proper ſize. Plumier informs us, in his *Art de Tourner*, that two plates are likewiſe united into one by heating and preſſing them; the edges being thoroughly cleaned, and made to fit cloſe to one another. The tortoiſe-ſhell is conveniently heated for this purpoſe by applying a hot iron above and beneath the juncture, with the interpoſition of a wet cloth to prevent the ſhell from being ſcorched by the irons: theſe irons ſhould be pretty thick, that they may not loſe their heat before the union is effected. Both tortoiſe-ſhell and horns may be ſtained of a variety of colours, by means of the colouring drugs commonly uſed in dying, and by certain metallic ſolutions.

TORTURE, a violent pain inflicted on perſons to force them to confeſs the crimes laid to their charge, or as a puniſhment for crimes committed.

Torture was never permitted among the Romans except in the examination of ſlaves: it would therefore appear, that it was a general opinion among them, that a ſlave had ſuch a tendency to falſehood, that the truth could only be extorted from him. To the diſgrace of the profeſſors of Chriſtianity, torture was long practiſed by thoſe who called themſelves Catholics, againſt thoſe whom they termed *heretics*; that is, thoſe who differed in opinion from themſelves. Finding that they could not bring over others to adopt their ſentiments by the force of argument, they judged it proper to compel them by the force of puniſhment. This practice was very general among orthodox Chriſtians, but eſpecially among Roman Catholics. See INQUISITION.

By the law of England, torture was at one period employed to compel thoſe criminals who ſtood obſtinately mute when brought to trial, and refuſed either to plead guilty or not guilty; but it is now aboliſhed (ſee ARRAIGNMENT, and RACK). A hiſtory of the machines which have been invented to torture men, and an account of the inſtances in which they have been employed, would exhibit a diſmal picture of the human character.

TORUS, in *Architecture*, a large round moulding uſed in the baſes of columns. See ARCHITECTURE.

TOUCAN. See RHAMPHASTOS, ORNITHOLOGY *Index*.

TOUCH-NEEDLE, among aſſayers, refiners. &c. little bars of gold, ſilver, and copper, combined together, in all the different proportions and degrees of mixture; the uſe of which is to diſcover the degree of purity of any piece of gold or ſilver, by comparing the mark it leaves on the touch-ſtone with thoſe of the bars.

The metals uſually tried by the touch-ſtone are gold, ſilver, and copper, either pure, or mixed with one another in different degrees and proportions, by fuſion. In order to find out the purity or quantity of baſer metal in theſe various admixtures, when they are to be examined they are compared with theſe needles, which are mixed in a known proportion, and prepared for this uſe. The metals of theſe needles, both pure and mixed, are all made into laminæ or plates, one-twelfth of an inch broad, and of a fourth part of their breadth in thickneſs, and an inch and half long; theſe being thus prepared, you are to engrave on each a mark indicating its purity, or the nature and quantity of the admixture in it. The black rough marbles, the baſaltes, or the ſofter kinds of black pebbles, are the moſt proper for touch-ſtones.

The method of uſing the needles and ſtone is thus: The piece of metal to be tried ought firſt to be wiped well with a clean towel or piece of ſoft leather, that you may the better ſee its true colour; for from this alone an experienced perſon, will in ſome degree, judge beforehand what the principal metal is, and how and with what debaſed.

Then chooſe a convenient, not over large, part of the ſurface of the metal, and rub it ſeveral times very hardly and ſtrongly againſt the touchſtone, that in caſe a deceitful coat or cruſt ſhould have been laid upon it, it may be worn off by that friction: this, however, is more readily done by a grindſtone or ſmall file. Then wipe a flat and very clear part of the touchſtone, and rub againſt it, over and over, the juſt mentioned part of the ſurface of the piece of metal, till you have, on the flat ſurface of the ſtone, a thin metallic cruſt, an inch long, and about an eighth of an inch broad: this done, look out the needle that ſeems moſt like to the metal under trial, wipe the lower part of this needle very clean, and then rub it againſt the touchſtone, as you did the metal, by the ſide of the other line, and in a direction parallel to it.

When this is done, if you find no difference between the colours of the two marks made by your needle and the metal under trial, you may with great probability pronounce that metal and your needle to be of the ſame alloy, which is immediately known by the mark engraved on your needle. But if you find a difference between the colour of the mark given by the metal, and that by the needle you have tried, chooſe out another needle, either of a darker or lighter colour than the former, as the difference of the tinge on the touchſtone directs; and by one or more trials of this kind you will be able to determine which of your needles the metal anſwers, and thence what alloy it is of, by the mark of the needle; or elſe you will find that the alloy is extraordinary, and not to be determined by the compariſon of your needles.

TOUCHSTONE, a black, ſmooth, gloſſy ſtone, uſed to examine the purity of metals. The ancients called it *lapis Lydius*, the Lydian ſtone, from the name of the country whence it was originally brought.

Any piece of pebble or black flint will anſwer the purpoſes of the beſt lapis lydius of Aſia. Even a piece of glaſs made rough with emery is uſed with ſucceſs, to diſtinguiſh true gold from ſuch as is counterfeit; both by the metallic colour and the teſt of aquafortis. The true touchſtone is of a black colour, and is not uncommon in many parts of the world.

TOUCHWOOD. See BOLETUS, BOTANY *Index*.

TOULON, a celebrated city and ſeaport of France, in that part of the late province of Provence which is now denominated the department of the *Var*. It is a very ancient place, having been founded, according to the common opinion, by a Roman general. It is the chief town of the department, and before the great revolution in 1789 was an epiſcopal ſee. The inhabitants are computed at 80,000. It is divided into the Old Quarter and the New Quarter. The firſt, which is very ill built, has nothing remarkable in it but the *Rue aux Arbres*, the Tree-Street, which is a kind of courſe or mall, and the town-houſe; the gate of this is ſurrounded by a balcony, which is ſupported by two termini, the maſterpieces of the famous Pujet. The New Quarter, which forms as it were a ſecond city, contains, beſide the magnificent works conſtructed in the reign of Louis XIV. many fine houſes (among which that of the late ſeminary merits beyond compariſon the preference) and a grand oblong ſquare, lined with trees, and ſerving as a parade.

The Merchants Haven, along which extends a noble quay, on which ſtands the town-houſe, is protected by two moles, begun by Henry IV. The New Haven was conſtructed by Louis XIV. as were the fortifications of the city. In the front of this haven is an arſenal, containing all the places neceſſary for the conſtruction and fitting out of veſſels: the firſt object that appears is a rope-walk, entirely arched, extending as far as the eye can reach, and built after the deſigns of Vauban: here cables are made, and above is a place for the preparation of hemp. Here likewiſe is the armoury for muſkets, piſtols, halberds, &c. In the park of artillery are cannons placed in piles, bombs, grenades, mortars, and balls of various kinds, ranged in wonderful order. The long ſail-room, the foundery for cannon, the dockyards, the baſons, &c. are all worthy of obſervation.

Both the Old and New Port have an outlet into the ſpacious outer road or harbour, which is ſurrounded by hills, and formed by nature almoſt circular. Its circuit is of very great extent, and the entrance is defended on both ſides by a fort with ſtrong batteries. In a word, the baſons, docks, and arſenal, at Toulon, warranted the remark of a foreigner that viſited them in the late reign, that "the king of France was greater there than at Verſailles." Toulon is the only mart in the Mediterranean for the re-exportation of the products of the Eaſt Indies.

This place was deſtroyed toward the end of the tenth century, and pillaged by the African pirates almoſt as ſoon as rebuilt. The conſtable of Bourbon, at the head of the Imperial troops, obtained poſſeſſion of it in 1524, as did Charles V. in 1536; but in the next century Charles Emanuel duke of Savoy could not enter it, and Prince Eugene in 1707 ineffectually laid ſiege to it. This city was ſurrendered by the inhabitants in September 1793 to the Britiſh admiral Lord Hood, as a condition and means of enabling them to effect the re-eſtabliſhment of monarchy in France, according to the conſtitution of 1789. Lord Hood accordingly, in conjunction with the Spaniſh land and naval forces, took poſſeſſion of the harbour and forts in truſt for Louis XVII. It was garriſoned for ſome time by the Britiſh troops, and their allies the Spaniards, Neapolitans, and Sardinians; but the French having laid ſiege to it, the garriſon was obliged to evacuate the place in the month of December following, after having deſtroyed the grand arſenal, two ſhips of 84 guns, eight of 74, and two frigates; and carried off the Commerce de Marſeilles, a ſhip of 120 guns, with an 80 and 74 gun ſhip. This exploit was moſt gallantly performed, after it was found impoſſible to defend the town, or to carry off the ſhips. Lord Hood entruſted the management of the affair to Sir Sydney Smith, ſo diſtinguiſhed for his intrepidity. Captain Hare commanded the fireſhip which was towed into the grand arſenal; and ſo eager was he to execute his orders, that inſtead of ſetting fire to the train in the uſual cautious manner, he fired a piſtol loaded with powder into the bowl of the train, compoſed of 36 pounds of powder, and other combuſtibles. The conſequence was, he was blown into the water with ſuch violence, as to knock a lieutenant of the Victory's boat overboard, and narrowly eſcaped with his life. A Spaniſh captain was appointed to ſet fire to the ſmall arſenal, but cowardice prevented him from executing his orders; and this is the reaſon why the whole French ſhips were not deſtroyed. We have been favoured with this account by an officer of the Britiſh fleet.

Toulon is ſeated on a bay of the Mediterranean, 17 leagues ſouth-eaſt of Aix, 15 ſouth-eaſt of Marſeilles, and 217 ſouth-eaſt of Paris. E. Long. 5. 56. N. Lat. 43. 7.

TOULOUSE, a very ancient city of France, in the department of Upper Garonne, and late province of Languedoc, with an archbiſhop's ſee. It is the moſt conſiderable city in France next to Paris and Lyons, although its population bears no proportion to its extent. According to Mr Neckar's calculation, it contains 56,000 inhabitants. The ſtreets are very handſome,

ſome, and the walls of the city, as well as the houſes, are built with bricks. The town-houſe, a modern ſtructure, forms a perfect ſquare, 324 feet long and 66 high. The principal front occupies an entire ſide of the grand ſquare, lately called the *Place Royale*. In the great hall, called the *Hall of Illuſtrious Men*, is the ſtatue of the Chevalier Iſaure, and the buſts of all the great men to whom Toulouſe has given birth. Communicating with the ocean on one ſide by the river Garonne, and with the Mediterranean on the other by the canal of Languedoc, Toulouſe might have been a great commercial city; but the taſte of the inhabitants has been directed to the ſciences and belles-lettres. Of courſe, there are two colleges, two public libraries, and three academies. The little commerce of Toulouſe conſiſts in leather, drapery, blankets, mignionets, oil, iron, mercery, hardware, and books. The bridge over the Garonne is at leaſt equal to thoſe of Tours and Orleans; it forms the communication between the ſuburb of St Cyprian and the city. The quays extend along the banks of the Garonne; and it has been in contemplation to line them with new and uniform houſes. Toulouſe is 37 miles eaſt of Auch, 125 ſouth-eaſt of Bourdeaux, and 350 ſouth-by-weſt of Paris. E. Long. 1. 27. N. Lat. 43. 36.

TOUR, Henry de la, Viſcount Turenne, a celebrated French general, was the ſecond ſon of Henry de la Tour duke of Bouillon, and was born at Sedan in 1611. He made his firſt campaigns in Holland, under Maurice and Frederic Henry princes of Orange; who were his uncles by the mother's ſide; and even then diſtinguiſhed himſelf by his bravery. In 1634 he marched with his regiment into Lorraine; and having contributed to the taking of La Mothe, was, though very young, made mareſchal de camp. In 1636 he took Saverne, and the year following the caſtles of Hirſon and Sole; on which occaſion he performed an action like that of Scipio's, with reſpect to a very beautiful woman whom he ſent back to her huſband. The viſcount Turenne continued to diſtinguiſh himſelf in ſeveral ſieges and battles, and in 1644 was made marſhal of France; but had the misfortune to be defeated at the battle of Mariendal in 1645. However, he gained the battle of Nortlingen three months after; reſtored the elector of Treves to his dominions; and the following year made the famous junction of the French army with that of Sweden commanded by General Wrangel, which obliged the duke of Bavaria to demand a peace. Afterwards that duke breaking the treaty he had concluded with France, he was defeated by the viſcount Turenne at the battle of Zumarſhauſen, and in 1648 driven entirely out of his dominions. During the civil wars in France he ſided with the princes, and was defeated at the battle of Rhetel in 1650; but ſoon after was reſtored to the favour of the king, who in 1652 gave him the command of his army. He acquired great honour at the battles of Jergeau, Gren, and the ſuburbs of St Anthony, and by the retreat he made before the army commanded by the princes at Ville Neuve St George. In 1654 he made the Spaniards raiſe the ſiege of Arras: the next year he took Conde, St Guilian, and ſeveral other places; gained the famous battle of Dunes; and made himſelf maſter of Dunkirk, Oudenarde, and almoſt all Flanders: this obliged the Spaniards to conclude the peace of the Pyrenees in 1660. Theſe important ſervices occaſioned his being made marſhal-general of the king's camps and armies. The war being renewed with Spain in 1667, Turenne commanded in Flanders; and took ſo many places, that in 1668 the Spaniards were obliged to ſue for peace. He commanded the French army in the war againſt the Dutch in 1672; took 40 towns in 22 days; purſued the elector of Brandenburg even to Berlin; gained the battles of Slintſheim, Ladenburg, Enſheim, Mulhauſen, and Turkeim; and obliged the Imperial army, which conſiſted of 70,000 men, to repaſs the Rhine. By this campaign the viſcount Turenne acquired immortal honour. He paſſed the Rhine to give battle to General Montecuculi, whom he followed as far as Saſpach; but mounting upon an eminence to diſcover the enemy's camp, he was killed by a cannon-ball in 1675. All France regretted the loſs of this great man, who by his military exploits had raiſed the admiration of Europe.

TOURAINE, a province of France, bounded on the north by Maine, on the eaſt by Orleanois, on the ſouth by Berris, and on the weſt by Anjou and Poitou. It is about 58 miles in length, and 55 in breadth where it is broadeſt. This country is watered by 17 rivers, beſides many brooks, which not only render it delightful, but keep up a communication with the neighbouring provinces. The air is temperate, and the ſoil is ſo fruitful that it is called the *garden of France*. It now forms the department of Indre and Loire, of which Tours is the capital.

TOURMALINE, a ſpecies of mineral belonging to the ſiliceous genus. See Mineralogy *Index*.

TOURNAMENT, a martial ſport or exerciſe which the ancient cavaliers uſed to perform, to ſhow their bravery and addreſs. It is derived from the French word *tourner*, i. e. "to turn round," becauſe to be expert in theſe exerciſes, much agility both of horſe and man was requiſite, they riding round a ring in imitation of the ancient Circi.

The firſt tournaments were only courſes on horſeback, wherein the cavaliers tilted at each other with canes in manner of lances; and were diſtinguiſhed from juſts, which were courſes or careers, accompanied with attacks and combats, with blunted lances and ſwords. See Just.

The prince who publiſhed the tournament, uſed to ſend a king at arms, with a ſafe-conduct, and a ſword, to all the princes, knights, &c. ſignifying that he intended a tournament and claſhing of ſwords, in the preſence of ladies and damſels; which was the uſual formula of invitation.

They firſt engaged man againſt man, and then troop againſt troop; and after the combat, the judges allotted the prize to the beſt cavalier, and the beſt ſtriker of ſwords; who was accordingly conducted in pomp to the lady of the tournament; where, after thanking her very reverently, he ſaluted her and likewiſe her two attendants.

Theſe tournaments made the principal diverſion of the 13th and 14th centuries. Munſter ſays, it was Henry the Fowler, duke of Saxony, and afterwards emperor, who died in 936, that firſt introduced them; but it appears from the chronicle of Tours, that the true inventor of this famous ſport, at leaſt in France, was one Geoffry, lord of Preuilli, about the year 1066.

Inſtances of them occur among the Engliſh in the reign of King Stephen, about the year 1140; but they were not much in uſe till Richard's time, towards the year 1149. After which period theſe diverſions were performed with extraordinary magnificence in the Tilt-yard near St James's, Smithfield, and other places.

The following is the account of a tournament, from Maitland. King Richard II. deſigning to hold a tournament at London on the Sunday after Michaelmas, ſent divers heralds to make proclamations of it in all the principal courts of Europe; and accordingly not a few princes, and great numbers of the prime nobility, reſorted hither from France, Germany, the Netherlands, &c. This ſolemnity began on Sunday afternoon, from the Tower of London, with a pompous cavalcade of 60 ladies, each leading an armed knight by a ſilver chain, being attended by their 'ſquires of honour, and, paſſing through Cheapſide, rode to Smithfield, where the juſts and tournaments continued ſeveral days with magnificent variety of entertainments; on which occaſion the king kept open houſe at the biſhop of London's palace for all perſons of diſtinction, and every night concluded with a ball.

At laſt, however, they were found to be productive of bad effects, and the occaſions of ſeveral fatal misfortunes—as in the inſtance of Henry II. of France, and of the tilt exhibited at Chalons, which, from the numbers killed on both ſides, was called the *little war of Chalons*. Theſe and other inconveniencies, reſulting from thoſe dangerous paſtimes, gave the popes occaſion to forbid them, and the princes of Europe gradually concurred in diſcouraging and ſuppreſſing them.

TOURNAY, a town of the Auſtrian Netherlands in Flanders, and capital of a diſtrict called *Tournaysis*, with a biſhop's ſee. It is divided into two parts by the river Scheldt; and is large, populous, well built, and carries on a great trade in woollen ſtuffs and ſtockings. The cathedral is a very handſome ſtructure, and contains a great many chapels, with rich ornaments, and ſeveral magnificent tombs of marble and braſs. The town was taken by the allies in 1709; but was ceded to the houſe of Auſtria by the treaty of Utrecht, though the Dutch had a right to put in a garriſon. It was taken by the French in June 1745, who demoliſhed the fortifications. In 1781 the emperor Joſeph II. obliged the Dutch to withdraw their garriſon. It was taken by the French in 1791, abandoned by them in 1793, and again conquered by them in 1794. It is 14 miles ſouth-eaſt of Liſle, 30 ſouth-weſt of Ghent, and 135 north by eaſt from Paris. E. Long. 3. 28. N. Lat. 50. 33.

TOURNEFORT, Joseph Pitton de, a famous French botaniſt, was born at Aix in Provence in 1656. He had a paſſion for plants from his childhood, which overcame his father's views in putting him to ſtudy philoſophy and divinity; therefore on his death he quitted theology, and gave himſelf up entirely to phyſic, natural hiſtory, and botany. He wandered over the mountains of Dauphiny, Savoy, Catalonia, the Pyrenees, and the Alps, in ſearch of new ſpecies of plants, which he acquired with much fatigue and danger. His fame in 1683 procured him the employment of botanic profeſſor, in the king's garden; and by the king's order, he travelled into Spain, Portugal, Holland, and England, where he made prodigious collections of plants. In 1700, Mr Tournefort, in obedience to another order, ſimpled over all the iſles of the Archipelago, upon the coaſts of the Black ſea, in Bithynia, Pontus, Cappadocia, Armenia, and Georgia; making obſervations on natural hiſtory at large, ancient and modern geography, religion, manners, and commerce. He ſpent three years in this learned voyage; and then reſuming his profeſſion, was made profeſſor of phyſic in the college-royal. He died in conſequence of an accidental cruſh of his breaſt by a cart-wheel, which brought on a ſpitting of blood and hydrothorax, that carried him off in 1708. He wrote Elements of Botany, both in French and Latin; A Relation of his Voyage into the Levant; with other pieces of leſs conſideration.

TOURNIQUET, in *Surgery*, an inſtrument formed with ſcrews, for compreſſing any part with rollers, &c. for the ſtopping of hæmorrhagies. See Surgery *Index*.

TOWER, a tall building conſiſting of ſeveral ſtories, uſually of a round form, though ſome are ſquare or polygonal. Towers are built for fortreſſes, &c. as the Tower of London. See London, N° 46.

TOWN, a place inhabited by a conſiderable number of people, being of a middle ſize between a city and a village.

TOXICODENDRON. See Rhus, Botany *Index*.

TRAAS. See Terras.

TRACHEA. See Anatomy, N° 119.

TRACHINUS, the Weever, a genus of fiſhes belonging to the order of jugulares. See Ichthyology *Index*.

TRACT, in *Geography*, an extent of ground, or a portion of the earth's ſurface.

Tract, in matters of literature, denotes a ſmall treatiſe or written diſcourſe upon any ſubject.

TRADE, in general, denotes the ſame with commerce, conſiſting in buying, ſelling, and exchanging of commodities, bills, money, &c. See Commerce, Coin, Money, Company, &c.

Trade-Winds, denote certain regular winds at ſea, blowing either conſtantly the ſame way, or alternately this way and that; thus called from their uſe in navigation, and the Indian commerce. See Meteorology.

TRADESMEN's tokens, a term ſynonymous among medaliſts with provincial coins.

This is a ſubject curious enough to deſerve attention, though we will not go ſo far as Mr Pinkerton does, who ſays that it is a ſubject in which the perpetual glory of the nation is intereſted. Since the year 1789 provincial halfpence have been made and circulated in conſiderable quantity. As ancient medals and coins have been frequently of uſe to hiſtorians, it is to be regretted that many of theſe provincial halfpence are rendered uſeleſs in this reſpect by unmeaning figures and puerile devices. Utility and elegance ought to be ſtudied: for this view it has been propoſed by a gentleman of taſte on this ſubject, that all coins ſhould be diſtinguiſhed by one of the following five characteriſtics. 1. Fac ſimiles of magnificent beautiful buildings. 2. Repreſentations of great and uſeful undertakings. 3. Emblems of the induſtry and commerce of the age. 4. The illuſtrious men, &c. to whom the nation has given birth. 5. Important hiſtorical events.

TRADITION, ſomething handed down from one generation to another without being written. Thus the

Jews pretended, that beſides their written law contained in the Old Teſtament, Moſes had delivered an oral law which had been conveyed down from father to ſon; and thus the Roman Catholics are ſaid to value particular doctrines ſuppoſed to have deſcended from the apoſtolic times by tradition.

TRAGACANTH. See ASTRAGALUS, MATERIA MEDICA *Index*.

TRAGEDY, a dramatic poem, repreſenting ſome ſignal action performed by illuſtrious perſons, and which has frequently a fatal iſſue or end. See POETRY, Part II. ſect. I.

TRAGI-COMEDY, a dramatic piece, partaking both of the nature of tragedy and comedy; in which a mixture of merry and ſerious events is admitted.

TRAGOPOGON, GOAT'S-BEARD; a genus of plants belonging to the claſs of ſyngeneſia; and in the natural ſyſtem ranging under the 49th order, *Compoſitæ*. See BOTANY *Index*.

TRAJAN, MARCUS ULPIUS, a celebrated Roman emperor, who gained many victories over the Parthians and Germans, puſhing the empire to its utmoſt extent on the eaſt and north ſides. He died at Silinunte, a city of Cilicia, which from him was called *Trajanopolis*, in the year 117.

TRAJAN'S Column, a famous hiſtorical column erected in Rome, in honour of the emperor Trajan. It is of the Tuſcan order, though ſomewhat irregular: its height is eight diameters, and its pedeſtal Corinthian: it was built in a large ſquare called *Forum Romanum*. Its baſe conſiſts of 12 ſtones of an enormous ſize, and is raiſed on a ſocle, or foot, of eight ſteps: withinſide is a ſtaircaſe illuminated with 44 windows. It is 140 feet high, which is 35 feet ſhort of the Antonine column, but the workmanſhip of the former is much more valued. It is adorned from top to bottom with baſſo relievos, repreſenting the great actions of the emperor againſt the Dacians.

TRAIN, a line of gunpowder laid to give fire to a quantity thereof, in order to do execution by blowing up earth, works, buildings, &c.

TRAIN of Artillery, includes the great guns and other pieces of ordnance belonging to an army in the field.

TRAIN-Oil, the oil procured from the blubber of a whale by boiling.

TRALLIAN, ALEXANDER, a Greek writer on phyſic, a native of Tralles in Lydia, who lived about the middle of the ſixth century. His works are divided into 12 books; in which he treats of diſtempers as they occur, from head to foot. He was the firſt who opened the jugular vein, and that uſed cantharides as a bliſter for the gout. Dr Freind, in his Hiſtory of Phyſic, ſtyles him one of the moſt valuable authors ſince the time of Hippocrates. Though he appears on the whole to have been a rational phyſician, yet there are things in his writings that ſavour of enthuſiaſm and ſuperſtition.

TRA-LOS-MONTES, a province of Portugal, called in Latin *Tranſmontana*, becauſe ſituated on the eaſt ſide of a chain of hills that ſeparate it from Entre Duero-e-Minho. It is bounded on the north by Galicia; on the ſouth by the provinces of Beira and Leon; by the laſt of which it is bounded alſo to the eaſt. Its length from north to ſouth is upwards of 120 miles, and its breadth about 80. It is full of mountains, and produces little corn, but plenty of wine, fruits of ſeveral ſorts, and abundance of game.

TRANSACTIONS, a name generally given to a collection of the papers read before literary or philoſophical ſocieties. The name of *Philoſophical Tranſactions* was firſt adopted by the Royal Society of London.

The Philoſophical Tranſactions to the end of the year 1700 were abridged in three volumes by Mr John Lowthorp: thoſe from the year 1700 to 1720 were abridged in two volumes by Mr Henry Jones: thoſe from 1719 to 1733 were abridged in two volumes by Mr John Eames and Mr John Martyn; Mr Martyn continued the abridgement of thoſe from 1732 to 1744 in two volumes, and of thoſe from 1743 to 1750 in two volumes.

They were for many years publiſhed in numbers, and the printing of them was always, from time to time, the ſingle act of the reſpective ſecretaries, till the year 1752, when the ſociety thought fit that a committee ſhould be appointed to reconſider the papers read before them, and to ſelect out of them ſuch as they ſhould judge moſt proper for publication in the future Tranſactions. They are publiſhed annually in two parts at the expence of the ſociety, and each fellow is entitled to receive one copy *gratis* of every volume publiſhed after his admiſſion into the ſociety.

They were firſt ſet on foot in 1665, by Mr Oldenburg, ſecretary of the ſociety, and were continued by him till the year 1677. Upon his death, they were diſcontinued till January 1678, when Dr Grew reſumed the publication of them, and continued it for the months of December 1678, and January and February 1679, after which they were intermitted till January 1683. During this laſt interval they were ſupplied in ſome meaſure by Dr Hooke's Philoſophical Collections. They were alſo interrupted for three years, from December 1687 to January 1691, beſide other ſmaller interruptions amounting to near one year and a half more, before October 1695, ſince which time the Tranſactions have been regularly carried on.

TRANSCENDENTAL, or TRANSCENDENT, ſomething elevated, or raiſed above other things; which paſſes and tranſcends the nature of other inferior things.

TRANSCRIPT, a copy of any original writing, particularly that of an act or inſtrument inſerted in the body of another.

TRANSFER, in commerce, an act whereby a perſon ſurrenders his right, intereſt, or property, in any thing moveable or immoveable to another.

TRANSFORMATION, in general, denotes a change of form, or the aſſuming a new form different from a former one.

TRANSFUSION, the act of pouring a liquor out of one veſſel into another.

TRANSFUSION of Blood, an operation by which it was ſome time ago imagined that the age of animals would be renewed, and immortality, or the next thing to it, conferred on thoſe who had undergone it.

The method of transfuſing Dr Lower gives us to the following effect: take up the carotid artery of the dog, or other animal, whoſe blood is to be transfuſed into another of the ſame, or a different kind; ſeparate it from the nerve of the eighth pair, and lay it bare above an inch. Make a ſtrong ligature on the upper part of the artery; and an inch nearer the heart another ligature with a running knot, to be looſened and faſtened as occaſion requires. Draw two threads between the two ligatures, open the artery, put in a quill, and tie up the artery again upon the quill by the two threads, and ſtop the quill by a ſtick.

Then make bare the jugular vein of the other animal for about an inch and a half in length, and at each end make a ligature with a running knot; and in the ſpace between the two knots draw under the veins two threads, as in the other. Open the vein, and put into it two quills, one into the deſcending part of the vein, to receive the blood from the other dog, and carry it to the heart; the other quill put into the other part of the jugular, towards the head, through which the ſecond animal's own blood is to run into diſhes. The quills thus tied faſt, ſtop them up with ſticks till there be occaſion to open them.

Things thus diſpoſed, faſten the dogs on their ſides towards one another, in ſuch manner as that the quills may go into each other; then unſtop the quill that goes down into the ſecond dog's jugular vein, as alſo that coming out of the other dog's artery; and by the help of two or three other quills put into each other, as there ſhall be occaſion, inſert them into one another. Then ſlip the running knots, and immediately the blood runs through the quills as through an artery, very impetuouſly. As the blood runs into the dog, unſtop the quill in the upper part of his jugular, for his own blood to run out at, though not conſtantly, but as you perceive him able to bear it, till the other dog begins to cry and faint, and at laſt die. *Laſtly*, Take both quills out of the jugular, tie the running knot faſt, and cut the vein aſunder, and ſew up the ſkin: the dog, thus diſmiſſed, will run away as if nothing ailed him.

In the Philoſophical Tranſactions we have accounts of the ſucceſs of various transfuſions practiſed at London, Paris, in Italy, &c. Sir Edmund King transfuſed forty-nine ounces of blood out of a calf into a ſheep; the ſheep, after the operation, appearing as well and as ſtrong as before.

M. Denis transfuſed the blood of three calves into three dogs, which all continued briſk, and ate as well as before. The ſame perſon transfuſed the blood of four wethers into a horſe twenty-ſix years old, which thence received much ſtrength, and a more than ordinary appetite.

Soon after this operation was introduced at Paris, viz. in 1667 and 1668, M. Denis performed it on five human ſubjects, two of whom recovered of diſorders under which they laboured, one being in perfect health ſuffered no inconvenience from it; and two perſons who were ill, and ſubmitted to the operation, died; in conſequence of which the magiſtrates iſſued a ſentence, prohibiting the transfuſion on human bodies under pain of impriſonment.

Mr John Hunter, we are told, made many ingenious experiments to determine the effects of transfuſing blood, ſome of which are ſufficient to attract attention. But whether ſuch experiments can ever be made with ſafety on the human body, is a point not eaſily determined. They might be allowed in deſperate caſes proceeding from a corruption of the blood, from poiſon, &c. as in hydrophobia.

TRANSIT, from *tranſit*, "it paſſes over," ſignifies the paſſage of any planet over the ſun, moon, or ſtars.

TRANSITION, the paſſage of any thing from one place to another.

TRANSITION, in *Oratory*. See ORATORY, N° 39.

TRANSITIVE, in *Grammar*, an epithet applied to ſuch verbs as ſignify an action which paſſes from the ſubject that does it, to or upon another ſubject which receives it. Under the head of verbs tranſitive come what we uſually call *verbs active* and *paſſive*; other verbs, whoſe action does not paſs out of themſelves, are called *neuters*.

TRANSLATION, the act of transferring or removing a thing from one place to another; as we ſay, the tranſlation of a biſhop's ſee, a council, a ſeat of juſtice, &c.

TRANSLATION is alſo uſed for the verſion of a book or writing out of one language into another.

The principles of tranſlation have been clearly and accurately laid down by Dr Campbell of Aberdeen in his invaluable Preliminary Diſſertations to his excellent tranſlations of the goſpels. The fundamental rules which he eſtabliſhes are three: 1. That the tranſlation ſhould give a complete tranſcript of the ideas of the original. 2. That the ſtyle and manner of the original ſhould be preſerved in the tranſlation. 3. That the tranſlation ſhould have all the eaſe of original compoſition. The rules deducible from theſe general laws are explained and illuſtrated with much judgement and taſte, in an Eſſay on the Principles of Tranſlation, by Mr Tytler, judge-advocate of Scotland.

TRANSMARINE, ſomething that comes from or belongs to the parts beyond ſea.

TRANSMIGRATION, the removal or tranſlation of a whole people into another country, by the power of a conqueror.

TRANSMIGRATION is particularly uſed for the paſſage of the ſoul out of one body into another. See METEMPSYCHOSIS.

TRANSMUTATION, the act of changing one ſubſtance into another.

Nature, ſays Sir Iſaac Newton, is delighted with tranſmutation: water, which is a fluid, volatile, taſteleſs, ſalt, is, by heat, tranſmuted into vapour, which is a kind of air; and by cold into ice, which is a cold, tranſparent, brittle ſtone, eaſily diſſolvable; and this ſtone is convertible again into water by heat, as vapour is by cold.—Earth, by heat, becomes fire, and, by cold, is turned into earth again: denſe bodies, by fermentation, are rarefied into various kinds of air; and that air, by fermentation alſo, and ſometimes without it, reverts into groſs bodies. All bodies, beaſts, fiſhes, inſects, plants, &c. with all their various parts, grow and increaſe out of water and aqueous and ſaline tinctures; and, by putrefaction, all of them revert into water, or an aqueous liquor again.

TRANSMUTATION, in alchemy, denotes the act of changing imperfect metals into gold or ſilver. This is alſo called the *grand operation*; and, they ſay, it is to be effected with the philoſopher's ſtone.

The trick of tranſmuting cinnabar into ſilver is thus: the cinnabar, being bruiſed groſsly, is ſtratified in a crucible with granulated ſilver, and the crucible placed in a great fire; and, after due time for calcination, taken off; then the matter, being poured out, is found to be cinnabar turned into real ſilver, though the ſilver grains appear in the ſame number and form as when they were put into the crucible; but the miſchief is, coming to handle the grains of ſilver, you find them nothing but light friable bladders, which will crumble to pieces between the fingers.

The tranſmutability of water into earth ſeems to have been believed by Mr Boyle; and Biſhop Watſon thinks that it has not yet been diſproved. See his *Chemical Eſſays*.

TRANSMUTATION of Acids, or *of Metals*, is the change of one acid or of one metal into another.

TRANSOM, among builders, denotes the piece that is framed acroſs a double-light window.

TRANSOMS, in a ſhip, certain beams or timbers extended acroſs the ſternpoſt of a ſhip, to fortify her afterpart, and give it the figure moſt ſuitable to the ſervice for which ſhe is calculated.

TRANSPARENCY, in *Phyſics*, a quality in certain bodies, whereby they give paſſage to the rays of light: in contradiſtinction to opacity, or that quality of bodies which renders them impervious to the rays of light.

It has been generally ſuppoſed by philoſophers, that tranſparent bodies have their pores diſpoſed in ſtraight lines, by which means the rays of light have an opportunity of penetrating them in all directions; but ſome experiments in electricity have made it apparent, that by the action of this fluid the moſt opaque bodies, ſuch as ſulphur, pitch, and ſealing-wax, may be rendered tranſparent as glaſs, while yet we cannot ſuppoſe the direction of their pores to be anyway altered from what it originally was (ſee ELECTRICITY). There is a curious inſtance of an increaſe of tranſparency in rubbing a piece of white paper over one that has been written upon or printed: while the white paper is at reſt, the writing or print will perhaps ſcarce appear through it; but when in motion, will be very eaſily legible, and continue ſo till the motion is diſcontinued.

TRANSPOSITION, in *Grammar*, a diſturbing or diſlocating the words of a diſcourſe, or a changing their natural order of conſtruction, to pleaſe the ear by rendering the contexture more ſmooth, eaſy, and harmonious.

TRANSUBSTANTIATION, in *Theology*, the converſion or change of the ſubſtance of the bread and wine in the euchariſt, into the body and blood of Jeſus Chriſt; which the Romiſh church ſuppoſe to be wrought by the conſecration of the prieſt. See *SUPPER of the Lord*, N° 5.

TRANSVERSALIS, in *Anatomy*, a name given to ſeveral muſcles. See ANATOMY, Part II.

TRANSVERSE, ſomething that goes acroſs another from corner to corner: thus bends and bars in heraldry are tranſverſe pieces or bearings; the diagonals of a parallelogram or a ſquare are tranſverſe lines.

TRANSYLVANIA, a province of Europe, annexed to Hungary, and bounded on the north by Upper Hungary and Poland, on the eaſt by Moldavia and Walachia, on the ſouth by Walachia, and on the weſt by Upper and Lower Hungary. It is ſurrounded on all parts by high mountains, which, however, are not barren. The inhabitants have as much corn and wine as they want themſelves; and there are rich mines of gold, ſilver, lead, copper, quickſilver, and alum. It has undergone various revolutions; but it now belongs to the houſe of Auſtria. The inhabitants are of ſeveral ſorts of religions; as Papiſts, Lutherans, Calviniſts, Socinians, Photinians, Arians, Greeks, and Mahometans. It is about 162 miles in length, and 150 in breadth. The adminiſtration of affairs is conducted by 12 perſons; namely, three Roman Catholics, three Lutherans, three Calviniſts, and three Socinians. The militia is commanded by the governor, whoſe commiſſion is the more important, as Tranſylvania is the bulwark of Chriſtendom. It is divided into ſeveral ſmall diſtricts, called *palatinates* and *counties*; and is inhabited by three different nations, Saxons, Sileſians, and Hungarians. Hermanſtadt is the capital town.

TRAPEZIUM, in *Geometry*, a plane figure contained under four unequal right lines.

TRAPEZIUS, a muſcle. See ANATOMY, Part II.

TRAPP, a compound rock. See GEOLOGY.

TRAVELLERS JOY. See CLEMATIS, BOTANY *Index*.

TRAVERSE, or TRANSVERSE, in general, denotes ſomething that goes athwart another; that is, croſſes and cuts it obliquely.

TRAVERSE, in *Navigation*, implies a compound courſe, or an aſſemblage of various courſes, lying at different angles with the meridian. See NAVIGATION.

TRAVERSE Board, a thin circular piece of board, marked with all the points of the compaſs, and having eight holes bored in each, and eight ſmall pegs hanging from the centre of the board. It is uſed to determine the different courſes run by a ſhip during the period of the watch, and to aſcertain the diſtance of each courſe.

TRAVESTY, a name given to an humorous tranſlation of any author. The word is derived from the French *traveſter* "to diſguiſe."

TREACLE, or MELASSES. See SUGAR.

TREACLE Beer. See SPRUCE.

TREACLE Muſtard. See CLYPEOLA, BOTANY *Index*.

TREASON, a general appellation, made uſe of by the law, to denote not only offences againſt the king and government, but alſo that accumulation of guilt which ariſes whenever a ſuperior repoſes a confidence in a ſubject or inferior, between whom and himſelf there ſubſiſts a natural, a civil, or even a ſpiritual relation; and the inferior ſo abuſes that confidence, ſo forgets the obligations of duty, ſubjection, and allegiance, as to deſtroy the life of any ſuch ſuperior or lord. Hence treaſon is of two kinds, *high* and *petty*.

High Treaſon, or *Treaſon Paramount* (which is equivalent to the *crimen læſæ majeſtatis* of the Romans, as Glanvil denominates it alſo in our Engliſh law), is an offence committed againſt the ſecurity of the king or kingdom, whether by imagination, word, or deed. In order to prevent the inconveniences which aroſe in England from a multitude of conſtructive treaſons, the ſtatute 25 Edw. III. c. 2. was made; which defines what offences only for the future ſhould be held to be treaſon; and this ſtatute comprehends all kinds of high-treaſon under ſeven diſtinct branches.

"1. When a man doth compaſs or imagine the death of our lord the king, of our lady his queen, or of their eldeſt ſon and heir." Under this deſcription it is held that a queen-regnant (ſuch as Queen Elizabeth and Queen

Queen Anne) is within the words of the act, being inveſted with royal power, and intitled to the allegiance of her ſubjects: but the huſband of ſuch a queen is not compriſed within theſe words; and therefore no treaſon can be committed againſt him.

Let us next ſee what is a *compaſſing* or *imagining* the death of the king, &c. Theſe are ſynonymous terms: the word *compaſs* ſignifying the purpoſe or deſign of the mind or will; and not, as in common ſpeech, the carrying ſuch deſign to effect. And therefore an accidental ſtroke, which may mortally wound the ſovereign, *per infortunium*, without any traitorous intent, is no treaſon: as was the caſe of Sir Walter Tyrrel, who, by the command of King William Rufus, ſhooting at a hart, the arrow glanced againſt a tree, and killed the king upon the ſpot. But as this compaſſing or imagination is an act of the mind, it cannot poſſibly fall under any judicial cognizance, unleſs it be demonſtrated by ſome open or overt act. The ſtatute expreſsly requires, that the accuſed "be thereof upon ſufficient proof attainted of ſome open act by men of his own condition." Thus, to provide weapons or ammunition for the purpoſe of killing the king, is held to be a palpable overt act of treaſon in imagining his death. To conſpire to impriſon the king by force, and move towards it by aſſembling company, is an overt act of compaſſing the king's death; for all force uſed to the perſon of the king, in its conſequence may tend to his death, and is a ſtrong preſumption of ſomething worſe intended than the preſent force, by ſuch as have ſo far thrown off their bounden duty to their ſovereign: it being an old obſervation, that there is generally but a ſhort interval between the priſons and the graves of princes. It ſeems clearly to be agreed, that by the common law and the ſtatute of Edw. III. words ſpoken amount only to a high miſdemeanor, and no treaſon. For they may be ſpoken in heat, without any intention; or be miſtaken, perverted, or miſremembered by the hearers; their meaning depends always on their connection with other words and things; they may ſignify differently even according to the tone of voice with which they are delivered; and ſometimes ſilence itſelf is more expreſſive than any diſcourſe. As therefore there can be nothing more equivocal and ambiguous than words, it would indeed be unreaſonable to make them amount to high treaſon. And accordingly, in 4 Car. I. on a reference to all the judges, concerning ſome very atrocious words ſpoken by one Pyne, they certified to the king, "that though the words were as wicked as might be, yet they were no treaſon; for unleſs it be by ſome particular ſtatute, no words will be treaſon." If the words be ſet down in writing, it argues more deliberate intention; and it has been held, that writing is an overt act of treaſon; for *ſcribere eſt agere*. But even in this caſe the bare words are not the treaſon, but the deliberate act of writing them.

2. The ſecond ſpecies of treaſon is, "if a man do violate the king's companion, or the king's eldeſt daughter unmarried, or the wife of the king's eldeſt ſon and heir." By the king's companion is meant his wife; and by violation is underſtood carnal knowledge, as well without force as with it: and this is high treaſon in both parties if both be conſenting; as ſome of the wives of Henry VIII. by fatal experience evinced.

3. The third ſpecies of treaſon is, "if a man do levy war againſt our lord the king in his realm." And this may be done by taking arms, not only to dethrone the king, but under pretence to reform religion, or the laws, or to remove evil counſellors, or other grievances whether real or pretended. For the law does not, neither can it, permit any private man, or ſet of men, to interfere forcibly in matters of ſuch high importance; eſpecially as it has eſtabliſhed a ſufficient power for theſe purpoſes in the high court of parliament: neither does the conſtitution juſtify any private or particular reſiſtance for private or particular grievances; though, in caſes of national oppreſſion, the nation has very juſtifiably riſen as one man, to vindicate the original contract ſubſiſting between the king and his people.

4. "If a man be adherent to the king's enemies in his realm, giving to them aid and comfort in the realm or elſewhere," he is alſo declared guilty of high-treaſon. This muſt likewiſe be proved by ſome overt act; as by giving them intelligence, by ſending them proviſions, by ſelling them arms, by treacherouſly ſurrendering a fortreſs, or the like.

5. "If a man counterfeit the king's great or privy ſeal," this is alſo high-treaſon. But if a man takes wax bearing the impreſſion of the great ſeal off from one patent, and fixes it to another, this is held to be only an abuſe of the ſeal, and not a counterfeiting of it: as was the caſe of a certain chaplain, who in ſuch a manner framed a diſpenſation for non-reſidence. But the knaviſh artifice of a lawyer much exceeded this of the divine. One of the clerks in chancery glued together two pieces of parchment; on the uppermoſt of which he wrote a patent, to which he regularly obtained the great ſeal, the label going through both the ſkins. He then diſſolved the cement, and taking off the written patent, on the blank ſkin, wrote a freſh patent of a different import from the former, and publiſhed it as true. This was held no counterfeiting of the great ſeal, but only a great miſpriſion; and Sir Edward Coke mentions it with ſome indignation that the party was living at that day.

6. The ſixth ſpecies of treaſon under this ſtatute is, "if a man counterfeit the king's money; and if a man bring falſe money into the realm counterfeit to the money of England, knowing the money to be falſe, to merchandiſe and make payment withal." As to the firſt branch, counterfeiting the king's money; this is treaſon, whether the falſe money be uttered in payment or not. Alſo if the king's own minters alter the ſtandard or alloy eſtabliſhed by law, it is treaſon. But gold and ſilver money only are held to be within this ſtatute. With regard likewiſe to the ſecond branch, importing foreign counterfeit money in order to utter it here; it is held that uttering it, without importing it, is not within the ſtatute.

7. The laſt ſpecies of treaſon aſcertained by this ſtatute is, "if a man ſlay the chancellor, treaſurer, or the king's juſtices of the one bench or the other, juſtices in eyre, or juſtices of aſſize, and all other juſtices aſſigned to hear and determine, being in their places doing their offices." Theſe high magiſtrates, as they repreſent the king's majeſty during the execution of their offices, are therefore for the time equally regarded by the law. But this ſtatute extends only to the actual killing of them; and not to wounding, or a bare attempt to kill them. It extends alſo only to the officers therein ſpecified; and therefore the barons of the exchequer, as ſuch, are not

within the protection of this act; but the lord keeper or commiſſioners of the great ſeal now ſeem to be within it, by virtue of the ſtatutes 5 Eliz. c. 18. and 1 W. and M. c. 21.

The new treaſons, created ſince the ſtatute 1 M. c. 1. and not comprehended under the deſcription of ſtatute 25 Edw. III. may be compriſed under three heads. The firſt ſpecies relates to Papiſts; the ſecond to falſifying the coin or other royal ſignatures, as falſely forging the ſign manual, privy ſignet, or privy ſeal, which ſhall be deemed high treaſon (1 M. ſtat. ii. c. 6.). The third new ſpecies of high treaſon is ſuch as was created for the ſecurity of the Proteſtant ſucceſſion in the houſe of Hanover. For this purpoſe, after the act of ſettlement was made, it was enacted by ſtatute 13 and 14 W. III. c. 3. that the pretended prince of Wales, aſſuming the title of King James III. ſhould be attainted of high treaſon; and it was made high-treaſon for any of the king's ſubjects to hold correſpondence with him or any perſon employed by him, or to remit money for his uſe. And by 17 Geo. II. c. 39. it is enacted, that if any of the ſons of the pretender ſhall land or attempt to land in this kingdom, or be found in the kingdom or any of its dominions, he ſhall be adjudged attainted of high-treaſon; and correſponding with them or remitting money to their uſe is made high-treaſon. By 1 Ann. ſtat. 2. c. 17. the offence of hindering the next in ſucceſſion from ſucceeding to the crown is high-treaſon: and by 6 Ann. c. 7. if any perſon ſhall maliciouſly, adviſedly, and directly, by writing or printing, maintain, that any other perſon hath any right to the crown of this realm, otherwiſe than according to the act of ſettlement, or that the kings of this realm with the authority of parliament are not able to make laws to bind the crown and its deſcent; ſuch perſon ſhall be guilty of high-treaſon.

The puniſhment of high treaſon in general is very ſolemn and terrible. 1. That the offender be drawn to the gallows, and not be carried or walk; though uſually (by connivance, at length ripened by humanity into law) a ſledge or hurdle is allowed, to preſerve the offender from the extreme torment of being dragged on the ground or pavement. 2. That he be hanged by the neck, and then cut down alive. 3. That his entrails be taken out, and burned while he is yet alive. 4. That his head be cut off. 5. That his body be divided into four parts. 6. That his head and quarters be at the king's diſpoſal.

The king may, and often doth, diſcharge all the puniſhment except beheading, eſpecially where any of noble blood are attainted. For beheading being part of the judgement, that may be executed, though all the reſt be omitted by the king's command. But where beheading is no part of the judgement, as in murder or other felonies, it hath been ſaid that the king cannot change the judgement, although at the requeſt of the party, from one ſpecies of death to another.

In the caſe of coining, which is a treaſon of a different complexion from the reſt, the puniſhment is milder for male offenders; being only to be drawn and hanged by the neck till dead. But in treaſons of every kind the puniſhment of women is the ſame, and different from that of men. For as the natural modeſty of the ſex forbids the expoſing and publicly mangling their bodies, their ſentence (which is to the full as terrible to ſenſe as the other) is to be drawn to the gallows, and there to be burned alive.

For the conſequences of this judgement, ſee ATTAINDER, FORFEITURE, and *CORRUPTION of Blood*.

Petty or *Petit Treaſon*, according to the ſtatute 25 Edward III. c. 2. may happen three ways: by a ſervant killing his maſter, a wife her huſband, or an eccleſiaſtical perſon (either ſecular or regular) his ſuperior, to whom he owes faith and obedience. A ſervant who kills his maſter whom he has left, upon a grudge conceived againſt him during his ſervice, is guilty of petty treaſon: for the traitorous intention was hatched while the relation ſubſiſted between them, and this is only an execution of that intention. So if a wife be divorced *a menſe et thoro*, ſtill the *vinculum matrimonii* ſubſiſts; and if ſhe kills ſuch divorced huſband, ſhe is a traitreſs. And a clergyman is underſtood to owe canonical obedience to the biſhop who ordained him, to him in whoſe dioceſe he is beneficed, and alſo to the metropolitan of ſuch ſuffragan or dioceſan biſhop; and therefore to kill any of theſe is petit treaſon. As to the reſt, whatever has been ſaid with reſpect to wilful MURDER, is alſo applicable to the crime of petit treaſon, which is no other than murder in its moſt odious degree; except that the trial ſhall be as in caſes of high treaſon, before the improvements therein made by the ſtatutes of William III. But a perſon indicted of petit treaſon may be acquitted thereof, and found guilty of manſlaughter or murder: and in ſuch caſe it ſhould ſeem that two witneſſes are not neceſſary, as in caſes of petit treaſon they are. Which crime is alſo diſtinguiſhed from murder in its puniſhment.

The puniſhment of petit treaſon in a man, is to be drawn and hanged, and in a woman to be drawn and burned: the idea of which latter puniſhment ſeems to have been handed down to us from the laws of the ancient Druids, which condemned a woman to be burned for murdering her huſband; and it is now the uſual puniſhment for all ſorts of treaſons committed by thoſe of the female ſex. Perſons guilty of petit treaſon were firſt debarred the benefit of clergy by ſtatute 12 Henry VII. c. 7. which has ſince been extended to their aiders, abettors, and counſellors, by ſtatutes 23 Henry VIII. c. 1, 4, and 5 P. and M. c. 4.

TREASURE, in general, denotes a ſtore or ſtock of money in reſerve.

TREASURE-Trove, in *Law*, derived from the French word *trover*, "to find," called in Latin *theſaurus inventus*, is where any money or coin, gold, ſilver, plate, or bullion, is found hidden in the earth or other private place, the owner thereof being unknown; in which caſe the treaſure belongs to the king: but if he that had hid it be known, or afterwards found out, the owner and not the king is intitled to it.

TREASURER, an officer to whom the treaſure of a prince or corporation is committed to be kept and duly diſpoſed of, in payment of officers and other expences. See TREASURY.

Of theſe there is great variety. His majeſty of Great Britain, in quality of elector of Hanover, is arch-treaſurer of the Roman empire. In England, the principal officers under this denomination are, the lord high-treaſurer, the treaſurer of the houſehold, treaſurer of the navy, of the king's chamber, &c.

The lord high-treaſurer of Great Britain, or firſt commiſſioner of the treaſury, when in commiſſion, has under his charge and government all the king's revenue which is kept in the exchequer. He holds his place during the king's pleaſure; being inſtituted by the delivery of a white ſtaff to him. He has the check of all the officers employed in collecting the cuſtoms and royal revenues: and in his gift and diſpoſition are all the offices of the cuſtoms in the ſeveral ports of the kingdom; eſcheators in every county are nominated by him; he alſo makes leaſes of the lands belonging to the crown.

The office of lord-treaſurer is now in commiſſion. The number of lords-commiſſioners is five; one of whom is the firſt lord, whoſe annual ſalary was formerly 383l. but is now 4000l.; and who, unleſs he be a peer, is alſo chancellor of the exchequer, and prime miniſter in the government of this country; the other lords commiſſioners have an annual ſalary of 1600l. each.

TREASURER of the Houſehold, is an officer who, in the abſence of the lord-ſteward, has power, with the comptroller and other officers of the green-cloth and the ſteward of the Marſhalſea, to hear and determine treaſons, felonies, and other crimes committed within the king's palace. See HOUSEHOLD.

There is alſo a treaſurer belonging to the eſtabliſhment of her majeſty's houſehold, &c.

TREASURER of the Navy, is an officer who receives money out of the exchequer, by warrant from the lord high-treaſurer, or the lords commiſſioners executing that place; and pays all charges of the navy, by warrant from the principal officers of the navy.

TREASURER of the County, he that keeps the county ſtock. There are two of them in each county, choſen by the major part of the juſtices of the peace, &c. at their general quarter ſeſſion; under previous ſecurity given for the money entruſted with them, and the faithful execution of the truſts repoſed in them.

TREASURY, the place wherein the revenues of a prince are received, preſerved and diſburſed. In England the treaſury is a part of the exchequer; by ſome called the *lower exchequer*. The officers of his majeſty's treaſury, or the lower exchequer, are the lords commiſſioners, one of whom is chancellor, two joint ſecretaries, private ſecretary to the firſt lord, two chamberlains, an auditor, four tellers, a clerk of the pells, uſhers of the receipt, a tally-cutter, &c. See each officer under his proper article, CHANCELLOR, TELLER, TALLY, &c.

Lords of the TREASURY. In lieu of one ſingle director and adminiſtrator of his majeſty's revenues under the title of *lord high treaſurer*, it is at preſent thought proper to put that office in commiſſion, i. e. to appoint ſeveral perſons to diſcharge it with equal authority, under the title of *lords commiſſioners of the treaſury*.

TREATISE, a ſet diſcourſe in writing on any ſubject.

TREATY, a covenant between two or more nations; or the ſeveral articles or conditions ſtipulated and agreed upon by two ſovereign powers.

TREBLE, in *Muſic*, the higheſt or moſt acute of the four parts in ſymphony, or that which is heard the cleareſt and ſhrilleſt in a concert.

TREBUCHET, TREBUCKET, *Tribuch* (*Terbichetum*), a tumbrel or cucking ſtool. Alſo a great engine to caſt ſtones to batter walls.

TREE, a large vegetable riſing with one woody ſtem to a conſiderable height.

Trees may be divided into two claſſes, *timber* and *fruit-trees*; the firſt including all thoſe trees which are uſed in machinery, ſhip-building, &c. or, in general, for purpoſes of utility; and the ſecond comprehending thoſe trees valued only, or chiefly, for their fruit. It is not neceſſary to form a third claſs to include trees uſed for fuel, as timber is uſed for this purpoſe where it is abundant; and where it is not abundant the branches of the timber trees, or ſuch of them as are dwarfiſh, unhealthy, or too ſmall for mechanical purpoſes, are uſed as fuel.

The anatomy and phyſiology of trees have already been given under the generic name PLANT and SAP.

Certain trees, it is well known, are natives of particular diſtricts; but many of them have been tranſplanted from their native ſoil, and now flouriſh luxuriantly in diſtant countries, ſo that it becomes a matter of very conſiderable difficulty to aſcertain their original ſoil. The following rules are given for this purpoſe by the Honourable Daines Barrington.

1. They muſt grow in large maſſes, and cover conſiderable tracts of ground, the woods not ending abruptly, by a change to other trees, except the ſituation and ſtrata become totally different. 2. They muſt grow kindly in copſes, and ſhoot from the ſtool, ſo as to continue for ever, if not very carefully grubbed up. 3. The ſeed muſt ripen kindly; nature never plants but where a ſucceſſion in the greateſt profuſion will continue. Laſtly, trees that give names to many places are probably indigenous.

The growth of trees is a curious and intereſting ſubject; yet few experiments have been made to determine what the additions are which a tree receives annually in different periods of its age. The only obſervations which we have ſeen on this ſubject worth repeating were made by the ingenious Mr Barker, to whom the Philoſophical Tranſactions are much indebted for papers containing an accurate regiſter of the weather, which he has kept for many years. He has drawn up a table to point out the growth of three kinds of trees, oaks, aſhes, and elms; which may be ſeen in the Philoſophical Tranſactions for 1788. We ſhall give his concluſions.

“ I find (ſays he) the growth of oak and aſh to be nearly the ſame. I have ſome of both ſorts planted at the ſame time, and in the ſame hedges, of which the oaks are the largeſt; but there is no certain rule as to that. The common growth of an oak or an aſh is about an inch in girth in a year; ſome thriving ones will grow an inch and a half; the unthriving ones not ſo much. Great trees grow more timber in a year than ſmall ones; for if the annual growth be an inch, a coat of one-ſixth of an inch is laid on all round, and the timber added to the body every year is its length multiplied into the thickneſs of the coat and into the girth, and therefore the thicker the tree is, the more timber is added.”

We will preſent our readers with a table, ſhowing the growth of 17 kinds of trees for two years. The trees grew at Cavenham in Suffolk.

N°	July 1785.		July 1786.		July 1787.	
	F.	In.	F.	In.	F.	In.
1 Oak	0	10½	0	11½	1	0½
2 Larch	1	0½	1	3	1	4
3 Scotch fir	1	3½	1	5½	1	7¾
4 Spruce fir	0	5¾	0	6½	0	7¼
5 Spaniſh cheſnut	0	7¼	0	7½	0	8
6 Elm	2	7½	2	9	2	11
7 Pinaſter	2	3½	2	4½	2	7½
8 Larch	1	5¼	1	6	1	7
9 Weymouth pine	0	5	0	6	0	7¾
10 Acacia	1	2¾	1	5¾	1	6½
11 Beech	0	6¼	0	6½	0	7¼
12 Plane, occidental	0	6½	0	7¾	0	8¾
13 Lombardy poplar	1	8	2	0	2	3¾
14 Black poplar	1	2¼	1	4½	1	5¾
15 Willow	2	9½	3	2	3	3
16 Silver fir	0	7¾	0	8¾	0	9¼
17 Lime	1	8½	1	10¾	2	0

See HUSBANDRY, N° 165, where the growth of 11 kinds of trees in 21 years is given.

Trees ſometimes attain a very great ſize: this muſt depend in a great meaſure on the richneſs of ſoil, but no leſs on the degree of heat. Indeed heat is ſo eſſential to the growth of trees, that as we go from the place within the polar circles where vegetation begins, and advance to the equator, we find the trees increaſe in ſize. Greenland, Iceland, and other places in the ſame latitude, yield no trees at all; and the ſhrubs which they produce are dwarfiſh; whereas, in warm climates, they often grow to an immenſe ſize. Mr Marſham ſaw ſpruce and ſilver firs in the dock-yard in Venice above 40 yards long, and one of 39 yards was 18 inches diameter at the ſmall end. He was informed that they came from Switzerland.

The largeſt tree in Europe, mentioned by travellers, is the cheſnut tree on Mount Etna, already deſcribed under the article ETNA, N° 18. It is a certain fact that trees acquire a very great ſize in volcanic countries. Beſide the multitude of fine groves in the neighbourhood of Albano in Italy, there are many detached oaks 20 feet in circumference, and many elms of the ſame ſize, eſpecially in the romantic way to Eaſtello, called the *Galleria*. In travelling by the ſide of the lake of Bolſena, the road leads through an immenſe number of oaks, ſpread upon beautiful hills. Where the lava has been ſufficiently ſoftened, they are clean and ſtraight, and of a conſiderable ſize; but where the lava has not been converted into a ſoil proper for ſtrong vegetation, they are round-headed, and of leſs ſize; however, taken all together, they make a magnificent appearance; and the ſpot itſelf ought to be ranked among the fine parts of Italy. The ſame may be obſerved of the ſmall lake of Vico, encompaſſed with gentle riſings, that are all clothed with foreſt-trees.

Some yews have been found in Britain 60 feet round. Palms in Jamaica attain the height of 200 feet; and ſome of the pines in Norfolk iſland are 280 feet high.

Of all the different kinds known in Europe, oak is beſt for building; and even when it lies expoſed to air and water, there is none equal to it. Fir-timber is the next in degree of goodneſs for building, eſpecially in England, where they build upon leaſes. It differs from oak in this, that it requires not much ſeaſoning, and therefore no great ſtock is required before-hand. Fir is uſed for flooring, wainſcoting, and the ornamental parts of building within doors. Elm is the next in uſe, eſpecially in England and France: it is very tough and pliable, and therefore eaſily worked: it does not readily ſplit; and it bears driving of bolts and nails better than any other wood; for which reaſon it is chiefly uſed by wheel-wrights and coach-makers, for ſhafts, naves, &c. Beech is alſo uſed for many purpoſes: it is very tough and white when young, and of great ſtrength; but liable to warp very much when expoſed to the weather, and to be worm eaten when uſed within doors; its greateſt uſe is for planks, bedſteads, chairs, and other houſehold goods. Aſh is likewiſe a very uſeful wood, but very ſcarce in moſt parts of Europe; it ſerves in buildings, or for any other uſe, when ſcreened from the weather; handſpikes and oars are chiefly made of it. Wild cheſnut timber is by many eſteemed to be as good as oak, and ſeems to have been much uſed in old buildings; but whether theſe trees are more ſcarce at preſent than formerly, or have been found not to anſwer ſo well as was imagined, it is certain that this timber is now but little uſed. Walnut-tree is excellent for the joiner's uſe, it being of a more curious brown colour than beech, and not ſo ſubject to the worms. The poplar, abele, and aſpen trees, which are very little different from each other, are much uſed inſtead of fir; they look well, and are tougher and harder.

The goodneſs of timber not only depends on the ſoil and ſituation in which it ſtands, but likewiſe on the ſeaſon wherein it is felled. In this people diſagree very much; ſome are for having it felled as ſoon as its fruit is ripe, others in the ſpring, and many in the autumn. But as the ſap and moiſture of timber is certainly the cauſe that it periſhes much ſooner than it otherwiſe would do, it ſeems evident, that timber ſhould be felled where there is the leaſt ſap in it, viz. from the time that the leaves begin to fall till the trees begin to bud. This work uſually commences about the end of April in England, becauſe the bark then riſes moſt freely; for where a quantity of timber is to be felled, the ſtatute requires it to be done then, for the advantage of tanning. The ancients chiefly regarded the age of the moon in felling their timber; their rule was to fell it in the wane, or four days after the new moon, or ſometimes in the laſt quarter. Pliny adviſes it to be in the very inſtant of the change; which happening to be in the laſt day of the winter ſolſtice, the timber, ſays he, will be incorruptible.

Timber ſhould likewiſe be cut when of a proper age; for when it is either too young or too old, it will not be ſo durable as when cut at a proper age. It is ſaid that oak ſhould not be cut under 60 years old, nor above 200. Timber, however, ſhould be cut in its prime, when almoſt fully grown, and before it begins to decay; and this will be ſooner or later according to the dryneſs and moiſtneſs of the ſoil where the timber grows, as alſo according to the bigneſs of the trees; for there are no fixed rules in felling of timber, experience and judgment muſt direct here as in moſt other caſes.

Great attention is neceſſary in the ſeaſoning of timber. Some adviſe the planks of timber to be laid for a few days in ſome pool or running ſtream, in order to extract the ſap, and afterwards to dry them in the ſun or air. By this means, it is ſaid, they will be prevented from either chopping, caſting, or cleaving; but againſt ſhrinking there is no remedy. Some again are for burying them in the earth, others in a heat; and ſome for ſcorching and ſeaſoning them in fire, eſpecially piles, poſts, &c. which are to ſtand in water or earth. The Venetians firſt found out the method of ſeaſoning by fire; which is done after this manner: They put the piece to be ſeaſoned into a ſtrong and violent flame; in this they continually turn it round by means of an engine, and take it out when it is everywhere covered with a black coaly cruſt; the internal part of the wood is thereby ſo hardened, that neither earth nor water can damage it for a long time afterwards.

Dr Plott ſays, it is found by long experience, that the trunk or body of the trees, when barked in the ſpring, and left ſtanding naked all the ſummer expoſed to the ſun and wind, are ſo dried and hardened, that the ſappy part in a manner becomes as firm and durable as the heart itſelf. This is confirmed by M. Buffon, who, in 1738, preſented to the royal academy of ſciences at Paris a memoir entitled, "An eaſy method of increaſing the ſolidity, ſtrength, and duration of timber;" for which purpoſe he obſerves, "nothing more is neceſſary than to ſtrip the tree entirely of its bark during the ſeaſon of the riſing of the ſap, and to leave it to dry completely before it be cut down."

By many experiments, particularly deſcribed in that eſſay, it appears, that the tree ſhould not be felled till the third year after it has been ſtripped of the bark; that it is then perfectly dry, and the ſap become almoſt as ſtrong as the reſt of the timber, and ſtronger than the heart of any other oak tree which has not been ſo ſtripped; and the whole of the timber ſtronger, heavier, and harder; from which he thinks it fair to conclude, that it is alſo more durable. "It would no longer (he adds) be neceſſary, if this method were practiſed, to cut off the ſap; the whole of the tree might be uſed as timber; one of 40 years growth would ſerve all the purpoſes for which one of 60 years is now required; and this practice would have the double advantage of increaſing the quantity, as well as the ſtrength and ſolidity, of the timber."

The navy board, in anſwer to the inquiries of the commiſſioners of the land revenue, in May 1789, informed them, that they had then ſtanding ſome trees ſtripped of their bark two years before, in order to try the experiment of building one half of a ſloop of war with that timber, and the other half with timber felled and ſtripped in the common way. This very judicious mode of making the experiment, if it be properly executed, will undoubtedly go far to aſcertain the effects of this practice. We are ſorry that we are not able to inform our readers what was the reſult of the experiment.

After the planks of timber have been well ſeaſoned and fixed in their places, care is to be taken to defend or preſerve them; to which the ſmearing them with linſeed oil, tar, or the like oleaginous matter, contributes much. The ancients, particularly Heſiod and Virgil, adviſe the ſmoke-drying of all inſtruments made of wood, by hanging them up in the chimneys where wood fires are uſed. The Dutch preſerve their gates, portcullices, drawbridges, ſluices, &c. by coating them over with a mixture of pitch and tar, whereon they ſtrew ſmall pieces of cockle and other ſhells, beaten almoſt to powder, and mixed with ſea-ſand, which incruſts and arms them wonderfully againſt all aſſaults of wind and weather. When timber is felled before the ſap is perfectly at reſt, it is very ſubject to worms; but to prevent and cure this, Mr Evelyn recommends the following remedy as the moſt approved: Put common ſulphur into a cucurbit, with as much aquafortis as will cover it three fingers deep; diſtil it to dryneſs, which is performed by two or three rectifications. Lay the ſulphur that remains at bottom, being of a blackiſh or ſand-red colour, on a marble, or put it in a glaſs, and it will diſſolve into an oil; with this oil anoint the timber which is infected with worms. This, he ſays, will not only prevent worms, but preſerve all kinds of woods, and many other things, as ropes, nets, and maſts, from putrefaction, either in water, air, or ſnow.

An experiment to determine the comparative durability of different kinds of timber, when expoſed to the weather, was made by a nobleman in Norfolk; of which an account is given by Sir Thomas Beevor. This nobleman, in the year 1774, ordered three poſts, forming two ſides of a quadrangle, to be fixed in the earth on a riſing ground in his park. Into theſe poſts were mortiſed planks, an inch and a half thick, cut out of trees from 30 to 45 years growth. Theſe, after ſtanding 10 years, were examined, and found in the following ſtate and condition:

Annals of Agriculture, vol. vi. p. 256.

The cedar was perfectly ſound; larch, the heart ſound, but the ſap quite decayed; ſpruce fir, ſound; ſilver fir, in decay; Scotch fir, much decayed; pinaſter, quite rotten; cheſnut, perfectly ſound; abele, ſound; beech, ſound; walnut, in decay; ſycamore, much decayed; birch, quite rotten. Sir Thomas Beevor juſtly remarks, that the trees ought to have been of the ſame age; and Mr Arthur Young adds, they ought to have been cut out of the ſame plantation.

The immenſe quantity of timber conſumed of late years in ſhip-building and other purpoſes has diminiſhed in a very great degree the quantity produced in this country. On this account, many gentlemen who wiſh well to their country, alarmed with the fear of a ſcarcity, have ſtrongly recommended it to government to pay ſome attention to the cultivation and preſervation of timber.

We find, on the beſt authority, that of Mr Irving inſpector general of imports and exports, that the ſhipping of England in 1760 amounted to 6107 in number, the tonnage being 433,922; and the ſhipping in Scotland amounted to 976 in number, the tonnage being 52,818. In 1788 the whole ſhipping of Britain and Ireland and their colonies amounted to 13,800, being 1,359,752 tons burden, and employing 107,925 men. The tonnage of the royal navy in the ſame year was 413,667. We are informed alſo, on what we conſider as the beſt authority (the report of the commiſſioners of the land revenue), that the quantity of oak timber, of Engliſh growth, delivered into the dockyards from 1760 to 1788 was no leſs than 768,676 loads, and that the quantity uſed in the merchants yards in the ſame time was 516,630 loads; in all 1,285,306 loads. The foreign oak uſed in the ſame period was only 137,766 loads.

Eleventh Report.

loads. So that, after deducting the quantity remaining in the dock-yards in 1760 and 1788, and the foreign oak, there will remain about 1,054,284 loads of Engliſh oak, conſumed in 28 years, which is at an average 37,653 loads per annum, beſides from 8300 to 10,000 loads expended annually by the Eaſt India company within the ſame period (A).

The price of wood has riſen in proportion to the demand and to its diminution. At the conqueſt, woods were valued, not by the quantity of timber which they contained, but the number of ſwine which the acorns could ſupport. In 1608, oak in the foreſts was ſold at 10s. per load, and fire-wood for 2s. per load. In 1663 or 1665, in navy contracts from 2l. to 2l. 15s. 6d. per load was given. In 1756 it roſe to 4l. 5s. per load, and 3s. in addition, becauſe no tops are received. Plank four inch ſold in 1769 for 7l. a load, three inch 6l.; which prices were the ſame in 1792.

So great an expenditure of valuable timber within ſo ſhort a period, gives reaſon to fear that the foreſts of this country will ſoon be entirely diſmantled, unleſs ſomething is done to raiſe freſh ſupplies. The building of a 70 gun ſhip, it is ſaid, would take 40 acres of timber. This calculation is indeed ſo exceſſive, that it is ſcarcely credible. This, however, is no exaggeration. According to the prevailing opinion of experienced ſurveyors, it will require a good ſoil and good management to produce 40 trees on an acre, which, in a hundred years, may, at an average, be computed at two loads each. Reckoning, therefore, two loads at 8l. 16s. one acre will be worth 350l. and conſequently 40 acres will only be worth 14,200l. Now a 70 gun ſhip is generally ſuppoſed to coſt 70,000l.; and as ſhips do not laſt a great many years, the navy continually requires new ſhips, ſo that the foreſts muſt be ſtripped in a century or two, unleſs young trees are planted to ſupply their place.

Many plans have been propoſed for recruiting the foreſts. Premiums have been held forth to individuals; and it has been propoſed that the crown-lands ſhould be ſet apart for the ſpecial purpoſe of raiſing timber. With reſpect to individuals, as they muſt generally be diſpoſed to ſow or plant their lands with thoſe vegetables which will beſt reward their labours, it is not to be expected that they will ſet apart their fields for planting trees unleſs they have a greater return from them than other crops. But bad muſt that land be which will not yield much more than 350l. produce in 100 years. But though it be evident that good land will produce crops much more lucrative to the proprietor than timber, yet ſtill there are lands or pieces of land which might be applied with very great advantage to the production of wood. Uneven ground, or the ſides of fields where corn cannot be cultivated, might very properly be ſet apart for this purpoſe; barren lands, or ſuch as cannot be cultivated without great labour and expence, might alſo be planted. Hedge-rows and clumps of trees, and little woods ſcattered up and down, would ſhelter and defend the fields from deſtructive winds, would beautify the face of the country, render the climate warmer, improve barren lands, and furniſh wood for the arts and manufactures.

But to cultivate foreſt timber has alſo been thought of ſuch national importance, that it has been deemed worthy of the attention of government. It has been propoſed to appropriate ſuch part of the crown-lands as are fit for the purpoſe ſolely of producing timber for the navy. This appears a very proper ſcheme in ſpeculation; but it has been objected, that for government to attempt the farming of foreſts would be really to eſtabliſh groups of officers to pocket ſalaries for doing what, it is well known, will never be done at all. But to this objection we reply, that ſuch an agreement might be made with the inſpectors of foreſts, as to make it their own intereſt to cultivate trees with as much care as poſſible. Their ſalary might be fixed very low, and raiſed in proportion to the number of trees which they could furniſh of ſuch a ſize in a certain number of years. After all, we muſt acknowledge that we muſt depend greatly on Ruſſia, Sweden, Norway, and America, for ſupplying us with timber; and while theſe countries take our manufactures in exchange, we have no reaſon to complain. Still, however, we ought ſurely not to neglect the cultivation of what is of ſo much importance to our exiſtence as a nation, for it may often be impoſſible in time of war to obtain timber from foreign countries.

In the beginning of this article we mentioned the general diviſion of trees into timber or foreſt-trees and fruit trees. We have already ſaid all that our limits will permit reſpecting the former: we will now, therefore, ſay ſomething of the latter. Our obſervations ſhall be confined to the methods of preſerving fruit trees in bloſſom from the effects of froſt, and from other diſeaſes to which they are liable.

European Magazine, March 1791.

The Chevalier de Dienenberg of Prague, we are told, has diſcovered a method of effectually preſerving trees in bloſſom from the fatal effects of thoſe froſts which ſometimes in the ſpring deſtroy the moſt promiſing hopes of a plentiful crop of fruit. His method is extremely ſimple. He ſurrounds the trunk of the tree in bloſſom with a wiſp of ſtraw or hemp. The end of this he ſinks, by means of a ſtone tied to it, in a veſſel of ſpring water, at a little diſtance from the tree. One veſſel will conveniently ſerve two trees: or the cord may be lengthened ſo as to ſurround ſeveral, before its end is plunged into the water. It is neceſſary that the veſſel be placed in an open ſituation, and by no means ſhaded by the branches of the neighbouring trees, that the froſt may produce all its effect on the water, by means of the cord communicating with it.—This precaution is particularly neceſſary for thoſe trees the flowers of which appear nearly at the ſame time as the leaves; which trees are peculiarly expoſed to the ravages of the froſt. The proofs of its efficacy, which he had an opportunity of obſerving in the ſpring

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(A) A writer in the Bath Tranſactions ſays, that the aggregate of oaks felled in England and Wales for 30 years paſt has amounted to 320,000 loads a-year; and affirms that he has documents in his poſſeſſion founded on indiſputable facts. The difference between this account, and that which we have given in the text from the report of the commiſſioners, we leave to be reconciled by thoſe who have proper opportunities. We give the facts merely on the authority of others.

ſpring of 1787, were remarkably ſtriking. Seven apricot eſpaliers in his garden began to bloſſom in the month of March. Fearing that they would ſuffer from the late froſts, he ſurrounded them with cords as above directed. In effect, pretty ſharp froſts took place ſix or eight nights: the apricot-trees in the neighbouring gardens were all frozen, and none of them produced any fruit, whilſt each of the chevalier's produced fruit in abundance, which came to the greateſt perfection.

The following is the method propoſed by Mr William Forſyth for curing injuries and defects in trees; for which a reward was given to him by his Majeſty, on condition that he ſhould make it public. It is equally applicable to foreſt as to fruit trees (B).

Take one buſhel of freſh cow-dung, half a buſhel of lime rubbiſh of old buildings (that from the ceilings of rooms is preferable); half a buſhel of wood aſhes; and a ſixteenth part of a buſhel of pit or river ſand. The three laſt articles are to be ſifted fine before they are mixed; then work them well together with a ſpade, and afterwards with a wooden beater, until the ſtuff is very ſmooth, like fine plaſter uſed for the ceilings of rooms. The compoſition being thus made, care muſt be taken to prepare the tree properly for its application by cutting away all the dead, decayed, and injured parts, till you come to the freſh ſound wood, leaving the ſurface of the wood very ſmooth, and rounding off the edges of the bark with a draw-knife, or other inſtrument, perfectly ſmooth, which muſt be particularly attended to. Then lay on the plaſter about one-eighth of an inch thick all over the part where the wood or bark has been ſo cut away, finiſhing off the edges as thin as poſſible. Then take a quantity of dry powder of wood aſhes, mixed with a ſixth part of the ſame quantity of the aſhes of burnt bones; put it into a tin box, with holes in the top, and ſhake the powder on the ſurface of the plaſter, till the whole is covered over with it, letting it remain for half an hour to abſorb the moiſture; then apply more powder, rubbing it on gently with the hand, and repeating the application of the powder, till the whole plaſter becomes a dry ſmooth ſurface.

All trees cut down near the ground ſhould have the ſurface made quite ſmooth, rounding it off in a ſmall degree, as before mentioned; and the dry powder directed to be uſed afterwards ſhould have an equal quantity of powder of alabaſter mixed with it, in order the better to reſiſt the dripping of trees and heavy rains. If any of the compoſition be left for a future occaſion, it ſhould be kept in a tub or other veſſel, and urine of any kind poured on it, ſo as to cover the ſurface; otherwiſe the atmoſphere will greatly hurt the efficacy of the application. Where lime rubbiſh of old buildings cannot be eaſily got, take powdered chalk, or common lime, after having been ſlaked a month at leaſt. As the growth of the tree will gradually affect the plaſter, by raiſing up its edges next the bark, care ſhould be taken, where that happens, to rub it over with the finger when occaſion may require (which is beſt done when moiſtened by rain), that the plaſter may be kept whole, to prevent the air and wet from penetrating into the wound.

Forſyth's Obſervations on the Diſeaſes of Trees.

By this proceſs, ſome old worn-out pear trees, that bore only a few ſmall, hard fruit, of a kernelly texture, were made to produce pears of the beſt quality and fineſt flavour the ſecond ſummer after the operation; and in four or five years they bore ſuch plenteous crops, as a young healthy tree would not have produced in four times that period.

By this proceſs, too, ſome large ancient elms, in a moſt decayed ſtate, having all their upper parts broken, and a ſmall portion only of the bark remaining, ſhot out ſtems from their tops, above thirty feet in height, in ſix or ſeven years from the firſt application of the compoſition.

Thus may valuable trees be renovated; and foreſt trees, which are uſeful or ornamental from their particular ſituation, be preſerved in a flouriſhing ſtate. But what is far more intereſting, a perfect cure has been made, and ſound timber produced, in oak trees, which had received very conſiderable damage from blows, bruiſes, cutting of deep letters, the rubbing off the bark by the ends of rollers, or wheels of carts, or from the breaking of branches by ſtorms.

TREFOIL. See TRIFOLIUM, BOTANY *Index.*

TREMELLA, a genus of plants belonging to the claſs of cryptogamia. See BOTANY *Index.*

TREMOR, an involuntary ſhaking, chiefly of the hands and head, ſometimes of the feet, and ſometimes of the tongue and heart.—Tremors ariſing from a too free uſe of ſpirituous liquors require the ſame treatment as palſies.

TRENCHES, in fortification, are ditches cut by the beſiegers, that they may approach the more ſecurely to the place attacked, whence they are alſo called *lines of approach.*

TRENT, BISHOPRIC OF, a province of Germany, in the circle of Auſtria, near the frontiers of Italy; is bounded on the north by Tirol; on the eaſt by the Feltrino and Belluneſe; on the ſouth, by Vincentino, the Veroneſe, Breſciano, and the lake de Garda; and on the weſt, by the Breſciano and the lake de Garda. The ſoil is ſaid to be very fruitful, and to abound in wine and oil.

TRENT, a city of Germany, and capital of the biſhopric of that name, is a very ancient place, and ſtands in a fertile and pleaſant plain, in the midſt of the high mountains of the Alps. The river Adige waſhes its walls, and creeping for ſome time among the hills, runs ſwiftly into Italy. Trent has three conſiderable churches, the principal of which is the cathedral: this is a very regular piece of architecture. The church of St Maria Major is all of red and white marble; and is remarkable for being the place where the famous council of Trent

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(B) A paſte for covering the wounds of trees, and the place where grafts are inſerted, was diſcovered long ago. It is recommended in a Treatiſe on Fruit Trees, publiſhed by Thomas Hitt in 1755; a third edition of which, with additions, was publiſhed in 1768. It conſiſts of a mixture of clay and cow's dung diluted with water. This paſte he directs to be laid on the wound with a bruſh; it adheres firmly, he ſays, without cracking till the wound heals. We are informed by a gentleman, to whoſe opinion and experience we pay great reſpect, that this paſte anſwers every purpoſe which Mr Forſyth's can ſerve.

Trent was held, whoſe deciſions are now the ſtanding rule of the Romiſh church. E. Long. 11. 5. N. Lat. 46. 10.

TRENT, one of the largeſt rivers in England, which riſes in the moorland of Staffordſhire, and runs ſouthweſt by Newcaſtle-under-Line; and afterwards dividing the county in two parts, runs to Burton, then to Nottingham and Newark: and ſo continuing its courſe due north to Gainſborough on the confines of Lincolnſhire, it joins ſeveral rivers, and falls into the Humber.

TRENT, *Council of*, in *Eccleſiaſtical Hiſtory*, denotes the council aſſembled by Paul III. in 1545, and continued by 25 ſeſſions till the year 1563, under Julius III. and Pius IV. in order to correct, illuſtrate, and fix with perſpicuity, the doctrine of the church, to reſtore the vigour of its diſcipline, and to reform the lives of its miniſters. The decrees of this council, together with the creed of Pope Pius IV. contain a ſummary of the doctrines of the Roman Catholics. Theſe decrees were ſubſcribed by 255 clergy, conſiſting of four legates, 2 other cardinals, 3 patriarchs, 25 archbiſhops, 168 biſhops, beſides inferior clergy. Of theſe 150 came from Italy, of courſe the council was entirely under the influence of the pope. For a more particular account of the council of Trent, ſee Moſheim's Church Hiſtory, the Modern Univerſal Hiſtory, vol. xxiii. and Father Paul's Hiſtory of the Council of Trent.

TRENTON. See *New JERSEY*.

TREPANNING. See SURGERY *Index*.

TRES TABERNÆ, in *Ancient Geography*, a place in Latium, lying on the Via Appia, on the left or ſouth ſide of the river Aſtura, to the north of the Paludes Pomptinæ. Its ruins are now ſeen near Ciſterna, a village in the Campagna di Roma, 21 miles from Rome, whence the Chriſtians went out to meet St Paul.

TRESPASS, in *Law*, ſignifies any tranſgreſſion of the law, under treaſon, felony, or miſpriſion of either: but it is commonly uſed for any wrong or damage that is done by one private perſon to another, or to the king in his foreſt.

TRESSLE TREES, in *Ship-Building*, two ſtrong bars of timber fixed horizontally on the oppoſite ſides of the lower maſt-head, to ſupport the frame of the top and the weight of the top-maſt.

TRESSURE, in *Heraldry*, a diminutive of an orle, uſually held to be half the breadth thereof.

TRET, in *Commerce*, an allowance made for the waſte or the dirt that may be mixed with any commodity; which is commonly four pounds in every 104 pounds weight.

TREVERI, or TREVIRI, in *Ancient Geography*, an ancient and a powerful people, both in horſe and foot, according to Cæſar; extending far and wide between the Meuſe and the Rhine. Their chief town was called *Treveris*. Now *Triers* or *Treves*.

TREVES, or TRIERS (in Latin *Trevere*, *Trevers*, *Treviris*, or *Auguſta Trevirorum*), the capital of the German archbiſhopric of the ſame name, ſtands 60 miles weſt of Mentz, 52 ſouth of Cologne, and 82 north of Straſburg. This city vies with moſt in Europe for antiquity, having been a large and noted town before Auguſtus ſettled a colony in it. It was free and imperial till the year 1560, when it was ſurpriſed and ſubjected by its archbiſhop James III. It ſtands on the Moſelle, over which it has a fair ſtone bridge. The cathedral is a large building; and near it ſtands the elector's palace, which not long ago was rebuilt. Here are three collegiate and five pariſh churches, three colleges of Jeſuits, thirteen monaſteries and nunneries, an univerſity founded in 1472, a houſe of the Teutonic order, and another of that of Malta, with ſome remains of the ancient Roman theatre. Roman coins and medals are often found in the ruins of the old city. In the cathedral they pretend to have our Saviour's coat and St Peter's ſtaff, to which they aſcribe miracles. The private houſes here are mean; and the city is neither well fortified nor inhabited. E. Long. 6. 41. N. Lat. 49. 45.

TRIAL, in *Law*, the examination of a cauſe according to the laws of the land before a proper judge; or it is the manner and order obſerved in the hearing and determining of cauſes.

Trials are either civil or criminal.

I. *Civil* TRIALS. The ſpecies of trials in civil caſes are ſeven: By *record*; by *inſpection* or examination; by *certificate*; by *witneſſes*; by wager of *battel*; by wager of *law*; and by *jury*. The firſt ſix are only had in certain ſpecial or eccentrical caſes, where the trial by jury would not be ſo proper or effectual: (See them explained under their reſpective titles). The nature of the laſt, that principal criterion of truth in the law of England, ſhall be explained in this article.

As trial by jury is eſteemed one of the moſt important privileges which members of ſociety can enjoy, and the bulwark of the Britiſh conſtitution, every man of reflection muſt be ſtimulated by the deſire of inquiring into its origin and hiſtory, as well as to be acquainted with the forms and advantages by which it is accompanied. We will therefore begin with tracing it to its origin. Its inſtitution has been aſcribed to our Saxon anceſtors by Sir William Blackſtone.

Blackſt. Comment. vol. iii. p. 349.

" Some authors (ſays that illuſtrious lawyer) have endeavoured to trace the original of juries up as high as the Britons themſelves, the firſt inhabitants of our iſland; but certain it is that they were in uſe among the earlieſt Saxon colonies, their inſtitution being aſcribed by Biſhop Nicholſon to Woden himſelf, their great legiſlator and captain. Hence it is, that we may find traces of juries in the laws of all thoſe nations which adopted the feodal ſyſtem, as in Germany, France, and Italy; who had all of them a tribunal compoſed of twelve good men and true, *boni homines*, uſually the vaſſals or tenants of the lord, being the equals or peers of the parties litigant; and, as the lord's vaſſals judged each other in the lord's courts, ſo the king's vaſſals, or the lords themſelves, judged each other in the king's court. In England we find actual mention of them ſo early as the laws of King Ethelred, and that not as a new invention. Stiernhook aſcribes the invention of the jury, which in the Teutonic language is denominated *nembda*, to Regner king of Sweden and Denmark, who was contemporary with our King Egbert. Juſt as we are apt to impute the invention of this, and ſome other pieces of juridical polity, to the ſuperior genius of Alfred the Great; to whom, on account of his having done much, it is uſual to attribute every thing: and as the tradition of ancient Greece placed to the account of their own Hercules whatever achievement was performed ſuperior to the ordinary proweſs of mankind. Whereas the truth ſeems to be, that this tribunal was univerſally eſtabliſhed among all the northern nations, and ſo interwoven in their very conſtitution,

conſtitution, that the earlieſt accounts of the one give us alſo ſome traces of the other."

This opinion has been controverted with much learning and ingenuity by Dr Pettingal in his Inquiry into the Uſe and Practice of Juries among the Greeks and Romans, who deduces the origin of juries from theſe ancient nations.

He begins with determining the meaning of the word δικασται in the Greek, and *judices* in the Roman, writers. "The common acceptation of theſe words (ſays he), and the idea generally annexed to them, is that of *preſidents of courts*, or, as we call them, *judges;* as ſuch they are underſtood by commentators, and rendered by critics. Dr Middleton, in his life of Cicero, expreſsly calls the judices, *judges of the bench:* and Archbiſhop Potter, and in ſhort all modern writers upon the Greek or Roman orators, or authors in general, expreſs δικασται and *judices* by ſuch terms as convey the idea of *preſidents in courts of juſtice.* The propriety of this is doubted of, and hath given occaſion for this inquiry; in which is ſhown, from the beſt Greek and Roman authorities, that neither the δικασται of the Greeks, or the *judices* of the Romans, ever ſignified *preſidents in courts of judicature*, or *judges of the bench;* but, on the contrary, they were diſtinguiſhed from each other, and the difference of their duty and function was carefully and clearly pointed out by the orators in their pleadings, who were the beſt authorities in thoſe caſes, where the queſtion related to forms of law, and methods of proceeding in judicial affairs and criminal proceſs.

The preſidents of the courts in criminal trials at Athens were the nine archons, or chief magiſtrates, of which whoever preſided was called ηγεμων δικαστηριου, or preſident of the court. Theſe nine preſided in different cauſes peculiar to each juriſdiction. The archon, properly ſo called, had belonging to his department all pupillary and heritable caſes; the βασιλευς or *rex ſacrorum*, the chief prieſt, all caſes where religion was concerned; the polemarchus, or general, the affairs of the army and all military matters; and the ſix theſmothetæ, the other ordinary ſuits.

Wherever then the ανδρες δικασται, or judicial men, are addreſſed by the Greek orators in their ſpeeches, they are not to be underſtood to be the preſiding magiſtrates, but another claſs of men, who were to inquire into the ſtate of the cauſe before them, by witneſſes and other methods of coming at truth; and after inquiry made and witneſſes heard, to report their opinion and verdict to the preſident, who was to declare it.

The ſeveral ſteps and circumſtances attending this judicial proceeding are ſo ſimilar to the forms obſerved by our jury, that the learned reader, for ſuch I muſt ſuppoſe him, cannot doubt but that the nature, intent, and proceedings of the δικαστηριον among the Greeks were the ſame with the Engliſh jury; namely, for the protection of the lower people from the power and oppreſſion of the great, by adminiſtering equal law and juſtice to all ranks; and therefore when the Greek orators directed their ſpeeches to the ανδρες δικασται, as we ſee in Demoſthenes, Æſchines, and Lyſias, we are to underſtand it in the ſame ſenſe as when our lawyers at the bar ſay, *Gentlemen of the jury.*

So likewiſe among the Romans, the *judices*, in their pleadings at the bar, never ſignified judges of the bench, or preſidents of the court, but a body or order of men, whoſe office in the courts of judicature was diſtinct from that of the prætor or *judex queſtionis*, which anſwered to our judge of the bench, and was the ſame with the archon, or ηγεμων δικαστηριου, of the Greeks: whereas the duty of the judices conſiſted in being impannelled, as we call it, challenged, and ſwore to try uprightly the caſe before them; and when they had agreed upon their opinion or verdict, to deliver it to the preſident who was to pronounce it. This kind of judicial proceſs was firſt introduced into the Athenian polity by Solon, and thence copied into the Roman republic, as probable means of procuring juſt judgement, and protecting the lower people from the oppreſſion or arbitrary deciſions of their ſuperiors.

When the Romans were ſettled in Britain as a province, they carried with them their *jura* and *inſtituta*, their laws and cuſtoms, which was a practice eſſential to all colonies; hence the Britons, and other countries of Germany and Gaul, learned from them the Roman laws and cuſtoms; and upon the irruption of the northern nations into the ſouthern kingdoms of Europe, the laws and inſtitutions of the Romans remained, when the power that introduced them was withdrawn: and Monteſquieu tells us, that under the firſt race of kings in France, about the fifth century, the Romans that remained, and the Burgundians their new maſters, lived together under the ſame Roman laws and police, and particularly the ſame forms of judicature. How reaſonable then is it to conclude, that in the Roman courts of judicature continued among the Burgundians, the form of a jury remained in the ſame ſtate it was uſed at Rome. It is certain, Monteſquieu, ſpeaking of thoſe times, mentions the *paires* or *hommes de fief*, homagers or peers, which in the ſame chapter he calls *juges*, *judges* or *jurymen:* ſo that we hence ſee how at that time the *hommes de fief*, or "men of the fief," were called *peers*, and thoſe peers were *juges* or jurymen. Theſe were the ſame as are called in the laws of the Confeſſor *pers de la tenure*, the "peers of the tenure, or homagers," out of whom the jury of peers were choſen, to try a matter in diſpute between the lord and his tenant, or any other point of controverſy in the manor. So likewiſe in all other parts of Europe, where the Roman colonies had been, the Goths ſucceeding them, continued to make uſe of the ſame laws and inſtitutions, which they found to be eſtabliſhed there by the firſt conquerors. This is a much more natural way of accounting for the origin of a jury in Europe, than having recourſe to the fabulous ſtory of Woden and his ſavage Scythian companions, as the firſt introducers of ſo humane and beneficent an inſtitution."

Trials by jury in civil cauſes are of two kinds; *extraordinary* and *ordinary.*

1. The firſt ſpecies of *extraordinary* trial by jury is that of the grand aſſiſe, which was inſtituted by King Henry II. in parliament, by way of alternative offered to the choice of the tenant or defendant in a writ of right inſtead of the barbarous and unchriſtian cuſtom of duelling. For this purpoſe a writ *de magna aſſiſa eligenda* is directed to the ſheriff, to return four knights, who are to elect and chooſe 12 others to be joined with them; and theſe all together form the grand aſſiſe, or great jury, which is to try the matter of right, and muſt now conſiſt of 16 jurors. Another ſpecies of extraordinary juries is the jury to try an attaint; which is a proceſs commenced againſt a former jury for bringing a falſe verdict. See the article ATTAINT.

2. With regard to the *ordinary* trial by jury in civil caſes, the moſt clear and perſpicuous way of treating it will be by following the order and courſe of the proceedings themſelves.

Blackſt. Comment.

When therefore an iſſue is joined by theſe words, "And this the ſaid A prays may be inquired of by the country;" or, "And of this he puts himſelf upon the country, and the ſaid B does the like;" the court awards a writ of *venire facias* upon the roll or record, commanding the ſheriff "that he cauſe to come here, on ſuch a day, twelve free and lawful men, *liberes et legales homines*, of the body of his country, by whom the truth of the matter may be better known, and who are neither of kin to the aforeſaid A nor the aforeſaid B, to recognize the truth of the iſſue between the ſaid parties." And ſuch writ is accordingly iſſued to the ſheriff. It is made returnable on the laſt return of the ſame term wherein iſſue is joined, viz. hilary or trinity terms; which, from the making up of the iſſues therein, are uſually called *iſſuable terms*. And he returns the names of the jurors in a panel (a little pane or oblong piece of parchment) annexed to the writ. This jury is not ſummoned, and therefore not appearing at the day muſt unavoidably make default. For which reaſon a compulſive proceſs is now awarded againſt the jurors, called in the common pleas a writ of *habeas corpora juratorum*, and in the King's Bench *diſtringas*, commanding the ſheriff to have their bodies, or to diſtrain them by their lands and goods, that they may appear upon the day appointed. The entry therefore on the roll of record is, "That the jury is reſpited, through defect of the jurors, till the firſt day of the next term, then to appear at Weſtminſter; unleſs before that time, viz. on Wedneſday the fourth of March, the juſtices of our lord the king appointed to take aſſizes in that county ſhall have come to Oxford, that is, to the place aſſigned for holding the aſſizes. Therefore the ſheriff is commanded to have their bodies at Weſtminſter on the ſaid firſt day of next term, or before the ſaid juſtice of aſſize, if before that time they come to Oxford, viz. on the fourth of March aforeſaid." And as the judges are ſure to come and open the circuit commiſſions on the day mentioned in the writ, the ſheriff returns and ſummons this jury to appear at the aſſizes; and there the trial is had before the juſtices of aſſize and *niſi prius*: among whom (as hath been ſaid [*]) are uſually two of the judges of the courts at Weſtminſter, the whole kingdom being divided into ſix circuits for this purpoſe. And thus we may obſerve, that the trial of common iſſues, at *niſi prius*, was in its original only a collateral incident to the original buſineſs of the juſtices of aſſize; though now, by the various revolutions of practice, it is become their principal civil employment; hardly any thing remaining in uſe of the real aſſizes but the name.

If the ſheriff be not an indifferent perſon, as if he be a party in the ſuit, or be related by either blood or affinity to either of the parties, he is not then truſted to return the jury; but the *venire* ſhall be directed to the coroners, who in this, as in many other inſtances, are the ſubſtitutes of the ſheriff to execute proceſs when he is deemed an improper perſon. If any exception lies to the coroners, the *venire* ſhall be directed to two clerks of the court, or two perſons of the county named by the court, and ſworn. And theſe two, who are called *eliſors*, or electors, ſhall indifferently name the jury, and their return is final; no challenge being allowed to their array.

Let us now pauſe a while, and obſerve (with Sir Matthew Hale [*]), in theſe firſt preparatory ſtages of the trial, how admirably this conſtitution is adapted and framed for the inveſtigation of truth beyond any other method of trial in the world. For, firſt, the perſon returning the jurors is a man of ſome fortune and conſequence; that ſo he may be not only the leſs tempted to commit wilful errors, but likewiſe be reſponſible for the faults of either himſelf or his officers: and he is alſo bound by the obligation of an oath faithfully to execute his duty. Next, as to the time of their return: the panel is returned to the court upon the original *venire*, and the jurors are to be ſummoned and brought in many weeks afterwards to the trial, whereby the parties may have notice of the jurors, and of their ſufficiency or inſufficiency, characters, connections, and relations, that ſo they may be challenged upon juſt cauſe; while, at the ſame time, by means of the compulſory proceſs (of *diſtringas*, or *habeas corpora*) the cauſe is not like to be retarded through defect of jurors. Thirdly, As to the place of their appearance: which in cauſes of weight and conſequence is at the bar of the court; but in ordinary caſes at the aſſiſes, held in the county where the cauſe of action ariſes, and the witneſſes and jurors live: a proviſion moſt excellently calculated for the ſaving of expence to the parties. For though the preparation of the cauſes in point of pleading is tranſacted at Weſtminſter, whereby the order and uniformity of proceeding is preſerved throughout the kingdom, and multiplicity of forms is prevented; yet this is no great charge or trouble, one attorney being able to tranſact the buſineſs of 40 clients. But the troubleſome and moſt expenſive attendance is that of jurors and witneſſes at the trial; which therefore is brought home to them, in the county where moſt of them inhabit. Fourthly, The perſons before whom they are to appear, and before whom the trial is to be held, are the judges of the ſuperior court, if it be a trial at bar; or the judges of aſſize, delegated from the courts at Weſtminſter by the king, if the trial be held in the country: perſons, whoſe learning and dignity ſecure their juriſdiction from contempt, and the novelty and very parade of whoſe appearance have no ſmall influence upon the multitude. The very point of their being ſtrangers in the county is of infinite ſervice, in preventing thoſe factions and parties which would intrude in every cauſe of moment, were it tried only before perſons reſident on the ſpot, as juſtices of the peace, and the like. And the better to remove all ſuſpicion of partiality, it was wiſely provided by the ſtatutes 4 Edw. III. c. 2. 8 Ric. II. c. 2. and 33 Hen. VIII. c. 24. that no judge of aſſiſe ſhould hold pleas in any county wherein he was born or inhabits. And as this inſtitution prevents party and faction from intermingling in the trial of right, ſo it keeps both the rule and the adminiſtration of the laws uniform. Theſe juſtices, though thus varied and ſhifted at every aſſizes, are all ſworn to the ſame laws, have had the ſame education, have purſued the ſame ſtudies, converſe and conſult together, communicate their deciſions and reſolutions, and preſide in thoſe courts which are mutually connected, and their judgements blended together, as they are interchangeably courts of appeal or advice to each other. And hence their adminiſtration of juſtice, and conduct

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[*] See the article *Aſſize*.

[*] *Hiſt.* C. L. c. 12.

conduct of trials, are conſonant and uniform; whereby that confuſion and contrariety are avoided, which would naturally ariſe from a variety of uncommunicating judges, or from any provincial eſtabliſhment. But let us now return to the aſſizes.

When the general day of trial is fixed, the plaintiff or his attorney muſt bring down the record to the aſſizes, and enter it with the proper officer, in order to its being called on in courſe.

Theſe ſteps being taken, and the cauſe called on in court, the record is then handed to the judge, to peruſe and obſerve the pleadings, and what iſſues the parties are to maintain and prove, while the jury is called and ſworn. To this end the ſheriff returns his compulſive proceſs, the writ of *habeas corpora*, or *diſtringas*, with the panel of jurors annexed, to the judge's officer in court.

The jurors contained in the panel are either ſpecial or common jurors. Special juries were originally introduced in trials at bar, when the cauſes were of too great nicety for the diſcuſſion of ordinary freeholders; or where the ſheriff was ſuſpected of partiality, though not upon ſuch apparent cauſe as to warrant an exception to him. He is in ſuch caſes, upon motion in court, and a rule granted thereupon, to attend the prothonotary or other proper officer with his freeholder's book; and the officer is to take indifferently 48 of the principal freeholders, in the preſence of the attorneys on both ſides: who are each of them to ſtrike off 12, and the remaining 24 are returned upon the panel. By the ſtatute 3 Geo. II. c. 25. either party is entitled upon motion to have a ſpecial jury ſtruck upon the trial of any iſſue, as well at the aſſizes as at bar, he paying the extraordinary expence, unleſs the judge will certify (in purſuance of the ſtatute 24 Geo. II. c. 18.) that the cauſe required ſuch ſpecial jury.

A common jury is one returned by the ſheriff according to the directions of the ſtatute 3 Geo. II. c. 25. which appoints, that the ſheriff or officer ſhall not return a ſeparate panel for every ſeparate cauſe, as formerly; but one and the ſame panel for every cauſe to be tried at the ſame aſſizes, containing not leſs than 48, nor more than 72, jurors: and that their names being written on tickets, ſhall be put into a box of glaſs; and when each cauſe is called, 12 of theſe perſons, whoſe names ſhall be firſt drawn out of the box, ſhall be ſworn upon the jury, unleſs abſent, challenged, or excuſed; or unleſs a previous view of the meſſuages, lands, or place in queſtion, ſhall have been thought neceſſary by the court; in which caſe, ſix or more of the jurors returned, to be agreed on by the parties, or named by a judge or other proper officer of the court, ſhall be appointed by ſpecial writ of *habeas corpora* or *diſtringas*, to have the matters in queſtion ſhown to them by two perſons named in the writ; and then ſuch of the jury as have had the view, or ſo many of them as appear, ſhall be ſworn on the inqueſt previous to any other jurors. Theſe acts are well calculated to reſtrain any ſuſpicion of partiality in the ſheriff, or any tampering with the jurors when returned.

As the jurors appear when called, they ſhall be ſworn, unleſs challenged by either party. See the article CHALLENGE.

If by means of challenges or other cauſe, a ſufficient number of unexceptionable jurors doth not appear at the trial, either party may pray a *tales*.

A *tales* is a ſupply of ſuch men as are ſummoned upon the firſt panel, in order to make up the deficiency. For this purpoſe a writ of *decem tales*, *octo tales*, and the like, was wont to be iſſued to the ſheriff at common law, and muſt be ſtill ſo done at a trial at bar, if the jurors make default. But at the aſſizes, or *niſi prius*, by virtue of the ſtatute 35 Hen. VIII. c. 6. and other ſubſequent ſtatutes, the judge is empowered at the prayer of either party to award a *tales de circumſtantibus* of perſons preſent in court, to be joined to the other jurors to try the cauſe; who are liable, however, to the ſame challenges as the principal jurors. This is uſually done till the legal number of 12 be completed; in which patriarchal and apoſtolical number Sir Edward Coke hath diſcovered abundance of myſtery.

When a ſufficient number of perſons impanelled, or taleſmen appear, they are then ſeparately ſworn, well and truly to try the iſſue between the parties, and a true verdict to give according to the evidence; and hence they are denominated "the jury," *jurata*, and "jurors," *ſc. juratores*.

The jury are now ready to hear the merits; and to fix their attention the cloſer to the facts which they are impanelled and ſworn to try, the pleadings are opened to them by counſel on that ſide which holds the affirmative of the queſtion in iſſue. For the iſſue is ſaid to lie, and proof is always firſt required upon that ſide which affirms the matter in queſtion: in which our law agrees with the civil, *ei incumbit probatio qui dicit, non qui negat; cum per rerum naturam factum-negantis probatio nulla ſit.* The opening counſel briefly informs them what has been tranſacted in the court above; the parties, the nature of the action, the declaration, the plea, replication, and other proceedings; and laſtly, upon what point the iſſue is joined, which is there ſent down to be determined. Inſtead of which, formerly the whole record and proceſs of the pleadings were read to them in Engliſh by the court, and the matter of iſſue clearly explained to their capacities. The nature of the caſe, and the evidence intended to be produced, are next laid before them by counſel alſo on the ſame ſide; and when their evidence is gone through, the advocate on the other ſide opens the adverſe caſe, and ſupports it by evidence; and then the party which began is heard by way of reply. See PLEADINGS.

Evidence in the trial by jury is of two kinds; either that which is given in proof, or that which the jury may receive by their own private knowledge. The former, or *proofs*, (to which in common ſpeech the name of evidence is uſually confined) are either written or parol; that is, by word of mouth. Written proofs, or evidence, are, 1. Records; and 2. Ancient deeds of 30 years ſtanding, which prove themſelves; but, 3. Modern deeds; and, 4. Other writings, muſt be atteſted and verified by parol evidence of witneſſes. With regard to parol evidence or witneſſes; it muſt firſt be remembered, that there is a proceſs to bring them in by writ of *ſubpœna ad teſtificandum;* which commands them, laying aſide all pretences and excuſes, to appear at the trial on pain of 100l. to be forfeited to the king; to which the ſtatute 5 Eliz. c. 9. has added a penalty of 10l. to the party aggrieved, and damages equivalent to the loſs ſuſtained by want of his evidence. But no witneſs, unleſs his reaſonable expences be tendered him, is bound to appear at all; nor, if he appear, is he bound to give evidence till ſuch charges are actually paid him; except he reſides within the bills of mortality, and is ſummoned to give evidence within the ſame. This compulſory proceſs, to bring in unwilling witneſſes, and the additional terrors of an attachment in caſe of diſobedience, are of excellent uſe in the thorough inveſtigation of truth: and, upon the ſame principle, in the Athenian courts, the witneſſes who were ſummoned to attend the trial had their choice of three things: either to ſwear to the truth of the fact in queſtion, to deny or abjure it, or elſe to pay a fine of 1000 drachmas.

All witneſſes, of whatever religion or country, that have the uſe of their reaſon, are to be received and examined, except ſuch as are infamous, or ſuch as are intereſted in the event of the cauſe. All others are competent witneſſes; though the jury from other circumſtances will judge of their credibility. Infamous perſons are ſuch as may be challenged as jurors, *propter delictum*: and therefore never ſhall be admitted to give evidence to inform that jury, with whom they were too ſcandalous to aſſociate. Intereſted witneſſes may be examined upon a *voir dire*, if ſuſpected to be ſecretly concerned in the event; or their intereſt may be proved in court. Which laſt is the only method of ſupporting an objection to the former claſs; for no man is to be examined to prove his own infamy. And no counſel, attorney, or other perſon, intruſted with the ſecrets of the cauſe by the party himſelf, ſhall be compelled, or perhaps allowed, to give evidence of ſuch converſation or matters of privacy as came to his knowledge by virtue of ſuch truſt and confidence: but he may be examined as to mere matters of fact, as the execution of a deed or the like, which might have come to his knowledge without being intruſted in the cauſe.

One witneſs (if credible) is ſufficient evidence to a jury of any ſingle fact: though undoubtedly the concurrence of two or more corroborates the proof. Yet our law conſiders that there are many tranſactions to which only one perſon is privy; and therefore does not always demand the teſtimony of two. Poſitive proof is always required, where, from the nature of the caſe, it appears it might poſſibly have been had. But, next to poſitive proof, circumſtantial evidence, or the doctrine of preſumptions, muſt take place: for when the fact itſelf cannot be demonſtratively evinced, that which comes neareſt to the proof of the fact is the proof of ſuch circumſtances which either neceſſarily or uſually attend ſuch facts; and theſe are called *preſumptions*, which are only to be relied upon till the contrary be actually proved.

The oath adminiſtered to the witneſs is not only that what he depoſes ſhall be true, but that he ſhall alſo depoſe the whole truth: ſo that he is not to conceal any part of what he knows, whether interrogated particularly to that point or not. And all this evidence is to be given in open court, in the preſence of the parties, their attorneys, the counſel, and all byſtanders; and before the judge and jury: each party having liberty to except to its competency, which exceptions are publicly ſtated, and by the judge are openly and publicly allowed or diſallowed, in the face of the country: which muſt curb any ſecret bias or partiality that might ariſe in his own breaſt.

When the evidence is gone through on both ſides, the judge, in the preſence of the parties, the counſel, and all others, ſums up the whole to the jury; omitting all ſuperfluous circumſtances, obſerving wherein the main queſtion and principal iſſue lies, ſtating what evidence has been given to ſupport it, with ſuch remarks as he thinks neceſſary for their direction, and giving them his opinion in matters of law ariſing upon that evidence.

The jury, after the proofs are ſummed up, unleſs the caſe be very clear, withdraw from the bar to conſider of their verdict; and in order to avoid intemperance and cauſeleſs delay, are to be kept without meat, drink, fire, or candle, unleſs by permiſſion of the judge, till they are unanimouſly agreed. A method of accelerating unanimity not wholly unknown in other conſtitutions of Europe, and in matters of greater concern. For by the golden bull of the empire, if, after the congreſs is opened, the electors delay the election of a king of the Romans for 30 days, they ſhall be fed only with bread and water till the ſame is accompliſhed. But if our juries eat or drink at all, or have any eatables about them, without conſent of the court, and before verdict, it is finable; and if they do ſo at his charge for whom they afterwards find, it will ſet aſide the verdict. Alſo, if they ſpeak with either of the parties or their agents after they are gone from the bar, or if they receive any freſh evidence in private, or if, to prevent diſputes, they caſt lots for whom they ſhall find, any of theſe circumſtances will entirely vitiate the verdict. And it has been held, that if the jurors do not agree in their verdict before the judges are about to leave the town, though they are not to be threatened or impriſoned, the judges are not bound to wait for them, but may carry them round the circuit from town to town in a cart. This neceſſity of a total unanimity ſeems to be peculiar to our own conſtitution; or at leaſt, in the *nembda* or jury of the ancient Goths, there was required (even in criminal caſes) only the conſent of the major part; and in caſe of an equality, the defendant was held to be acquitted.

When they are all unanimouſly agreed, the jury return back to the bar; and before they deliver their verdict, the plaintiff is bound to appear in court, by himſelf, attorney, or counſel, in order to anſwer the amercement to which by the old law he is liable, in caſe he fails in his ſuit, as a puniſhment for his falſe claim. To be amerced, or *a mercie*, is to be at the king's mercy with regard to the fine to be impoſed; in *miſericordia domini regis pro falſo clamore ſuo*. The amercement is diſuſed, but the form ſtill continues; and if the plaintiff does not appear, no verdict can be given; but the plaintiff is ſaid to be nonſuit, *non ſequitur clamorem ſuum*. Therefore it is uſual for a plaintiff, when he or his counſel perceives that he has not given evidence ſufficient to maintain his iſſue, to be voluntarily nonſuited, or withdraw himſelf: whereupon the crier is ordered to call the plaintiff; and if neither he, nor any body for him, appears, he is nonſuited, the jurors are diſcharged, the action is at an end, and the defendant ſhall recover his coſts. The reaſon of this practice is, that a nonſuit is more eligible for the plaintiff than a verdict againſt him: for after a nonſuit, which is only a default, he may commence the ſame ſuit again for the ſame cauſe of action; but after a verdict had, and judgment conſequent thereupon, he is for ever barred from attacking the defendant upon the ſame ground of complaint. But in caſe the plaintiff appears, the jury by their foreman deliver in their verdict.

A verdict, *vere dictum*, is either privy or public. A privy verdict is when the judge hath left or adjourned the court: and the jury, being agreed, in order to be delivered from their confinement, obtain leave to give their verdict privily to the judge out of court: which privy verdict is of no force, unleſs afterwards affirmed by a public verdict given openly in court; wherein the jury may, if they pleaſe, vary from their privy verdict. So that the privy verdict is indeed a mere nullity; and yet it is a dangerous practice, allowing time for the parties to tamper with the jury, and therefore very ſeldom indulged. But the only effectual and legal verdict is the public verdict: in which they openly declare to have found the iſſue for the plaintiff, or for the defendant; and if for the plaintiff, they aſſeſs the damages alſo ſuſtained by the plaintiff, in conſequence of the injury upon which the action is brought.

When the jury have delivered in their verdict, and it is recorded in court, they are then diſcharged; and ſo ends the trial by jury: a trial which ever has been, and it is hoped ever will be, looked upon as the glory of the Engliſh law. It is certainly the moſt tranſcendant privilege which any ſubject can enjoy or wiſh for, that he cannot be affected either in his property, his liberty, or his perſon, but by the unanimous conſent of 12 of his neighbours and equals. A conſtitution that we may venture to affirm has, under providence, ſecured the juſt liberties of this nation for a long ſucceſſion of ages. And therefore a celebrated French writer*, who concludes, that becauſe Rome, Sparta, and Carthage, have loſt their liberties, therefore thoſe of England in time muſt periſh, ſhould have recollected, that Rome, Sparta, and Carthage, at the time when their liberties were loſt, were ſtrangers to the trial by jury.

Great as this eulogium may ſeem, it is no more than this admirable conſtitution, when traced to its principles, will be found in ſober reaſon to deſerve.

The impartial adminiſtration of juſtice, which ſecures both our perſons and our properties, is the great end of civil ſociety. But if that be entirely entruſted to the magiſtracy, a ſelect body of men, and thoſe generally ſelected by the prince or ſuch as enjoy the higheſt offices in the ſtate, their deciſions, in ſpite of their own natural integrity, will have frequently an involuntary bias towards thoſe of their own rank and dignity: it is not to be expected from human nature, that the few ſhould be always attentive to the intereſts and good of the many. On the other hand, if the power of judicature were placed at random in the hands of the multitude, their deciſions would be wild and capricious, and a new rule of action would be every day eſtabliſhed in our courts. It is wiſely therefore ordered, that the principles and axioms of law, which are general propoſitions flowing from abſtracted reaſon, and not accommodated to times or to men, ſhould be depoſited in the breaſts of the judges, to be occaſionally applied to ſuch facts as come properly aſcertained before them. For here partiality can have little ſcope; the law is well known, and is the ſame for all ranks and degrees: it follows as a regular concluſion from the premiſſes of fact pre-eſtabliſhed. But in ſettling and adjuſting a queſtion of fact, when intruſted to any ſingle magiſtrate, partiality and injuſtice have an ample field to range in, either by boldly aſſerting that to be proved which is not ſo, or more artfully by ſuppreſſing ſome circumſtances, ſtretching and warping others, and diſtinguiſhing away the remainder. Here therefore a competent number of ſenſible and upright jurymen, choſen by lot from among thoſe of the middle rank, will be found the beſt inveſtigators of truth, and the ſureſt guardians of public juſtice. For the moſt powerful individual in the ſtate will be cautious of committing any flagrant invaſion of another's right, when he knows that the fact of his oppreſſion muſt be examined and decided by 12 indifferent men not appointed till the hour of trial; and that when once the fact is aſcertained, the law muſt of courſe redreſs it. This therefore preſerves in the hands of the people that ſhare which they ought to have in the adminiſtration of public juſtice, and prevents the encroachments of the more powerful and wealthy citizens.

Criminal TRIALS. The regular and ordinary method of proceeding in the courts of criminal juriſdiction may be diſtributed under 12 general heads, following each other in a progreſſive order: viz. 1. Arreſt; 2. Commitment and bail; 3. Proſecution; 4. Proceſs; 5. Arraignment, and its incidents; 6. Plea, and iſſue; 7. Trial, and conviction; 8. Clergy; 9. Judgement, and its conſequences; 10. Reverſal of judgement; 11. Reprieve, or pardon; 12. Execution. See ARREST, COMMITMENT, PRESENTMENT, INDICTMENT, INFORMATION, APPEAL, *PROCESS upon an Indictment*, ARRAIGNMENT, and PLEA; in which articles all the forms which precede the trial are deſcribed, and are here enumerated in the proper order.

The ſeveral methods of trial and conviction of offenders, eſtabliſhed by the laws of England, were formerly more numerous than at preſent, through the ſuperſtition of our Saxon anceſtors; who, like other northern nations, were extremely addicted to divination; a character which Tacitus obſerves of the ancient Germans. They therefore invented a conſiderable number of methods of purgation or trial, to preſerve innocence from the danger of falſe witneſſes, and in conſequence of a notion that God would always interpoſe miraculouſly to vindicate the guiltleſs; as, 1. By ORDEAL; 2. By CORSNED; 3. By BATTEL. See theſe articles

4. A fourth method is that by the *peers of Great Britain*, in the *Court of PARLIAMENT*; or the *Court of the Lord High STEWARD*, when a peer is capitally indicted; for in caſe of an appeal, a peer ſhall be tried by jury. This differs little from the trial *per patriam*, or by jury; except that the peers need not all agree in their verdict; and except alſo, that no ſpecial verdict can be given in the trial of a peer; becauſe the lords of parliament, or the lord high ſteward (if the trial be had in his court), are judges ſufficiently competent of the law that may ariſe from the fact; but the greater number, conſiſting of 12 at the leaſt, will conclude, and bind the minority.

The trial by jury, or the country, *per patriam*, is alſo that trial by the peers of every Briton, which, as the great bulwark of his liberties, is ſecured to him by the great charter: *nullus liber homo capiatur, vel impriſonetur, aut exulet, aut aliquo alio modo deſtruatur, niſi per legale judicium parium ſuorum, vel per legem terræ.*

When therefore a priſoner on his ARRAIGNMENT has pleaded not guilty, and for his trial hath put himſelf

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* *Monteſquieu, Spir. L.* xi. 6.

upon the country, which country the jury are, the ſheriff of the county muſt return a panel of jurors, *liberos et legales homines, de viceneto;* that is, freeholders without juſt exception, and of the *viſne* or neighbourhood; which is interpreted to be of the county where the fact is committed. If the proceedings are before the court of king's bench, there is time allowed between the arraignment and the trial, for a jury to be impanelled by writ of *venire facias* to the ſheriff, as in civil cauſes; and the trial in caſe of a miſdemeanor is had at *niſi prius,* unleſs it be of ſuch conſequence as to merit a trial at bar; which is always invariably had when the priſoner is tried for any capital offence. But, before commiſſioners of oyer and terminer and goal-delivery, the ſheriff, by virtue of a general precept directed to him beforehand, returns to the court a panel of 48 jurors, to try all felons that may be called upon their trial at that ſeſſion; and therefore it is there uſual to try all felons immediately or ſoon after their arraignment. But it is not cuſtomary, nor agreeable to the general courſe of proceedings, unleſs by conſent of parties, to try perſons indicted of ſmaller miſdemeanors at the ſame court in which they have pleaded not guilty, or traverſed the indictment. But they uſually give ſecurity to the court to appear at the next aſſiſes or ſeſſion, and then and there to try the traverſe, giving notice to the proſecutor of the ſame.

In caſes of high-treaſon, whereby corruption of blood may enſue (except treaſon in counterfeiting the king's coin or ſeals), or miſpriſion of ſuch treaſon, it is enacted by ſtatute 7 W. III. c. 3. firſt, that no perſon ſhall be tried for any ſuch treaſon, except an attempt to aſſaſſinate the king, unleſs the indictment be found within three years after the offence committed: next, that the priſoner ſhall have a copy of the indictment (which includes the caption), but not the names of the witneſſes, five days at leaſt before the trial, that is, upon the true conſtruction of the act, before his arraignment; for then is his time to take any exceptions thereto, by way of plea or demurrer; thirdly, that he ſhall alſo have a copy of the panel of jurors two days before his trial: and, laſtly, that he ſhall have the ſame compulſive proceſs to bring in his witneſſes for him, as was uſual to compel their appearance againſt him. And by ſtatute 7 Ann. c. 21. (which did not take place till after the deceaſe of the late pretender) all perſons indicted for high-treaſon, or miſpriſions thereof, ſhall have not only a copy of the indictment, but a liſt of all the wineſſes to be produced, and of the jurors impanelled, with their profeſſions and places of abode, delivered to him ten days before the trial, and in the preſence of two witneſſes, the better to prepare him to make his challenges and defence. And no perſon indicted for felony is, or (as the law ſtands) ever can be, entitled to ſuch copies before the time of his trial.

When the trial is called on, the jurors are to be ſworn as they appear, to the number of 12, unleſs they are challenged by the party.

Challenges may here be made, either on the part of the king, or on that of the priſoner; and either to the whole array, or to the ſeparate polls, for the very ſame reaſons that they may be made in civil cauſes. But in criminal caſes, or at leaſt in capital ones, there is, *in favorem vitæ*, allowed to the priſoner an arbitrary and capricious ſpecies of challenge, to a certain number of jurors, without ſhowing any cauſe at all; which is called a *peremptory* challenge; a proviſion full of that tenderneſs and humanity to priſoners for which our Engliſh laws are juſtly famous. This is grounded on two reaſons. 1. As every one muſt be ſenſible what ſudden impreſſions and unaccountable prejudices we are apt to conceive upon the bare looks and geſtures of another; and how neceſſary it is that a priſoner) when put to defend his life) ſhould have a good opinion of his jury, the want of which might totally diſconcert him; the law wills not that he ſhould be tried by any one man againſt whom he has conceived a prejudice, even without being able to aſſign a reaſon for ſuch his diſlike. 2. Becauſe, upon challenges for cauſe ſhown, if the reaſon aſſigned prove inſufficient to ſet aſide the juror, perhaps the bare queſtioning his indifference may ſometimes provoke a reſentment; to prevent all ill conſequences from which, the priſoner is ſtill at liberty, if he pleaſes, peremptorily to ſet him aſide.

The peremptory challenges of the priſoner muſt, however, have ſome reaſonable boundary; otherwiſe he might never be tried. This reaſonable boundary is ſettled by the common law to be the number of 35; that is, one under the number of three full juries.

If by reaſon of challenges or the default of the jurors, a ſufficient number cannot be had of the original panel, a tales may be awarded as in civil cauſes, till the number of 12 is ſworn, "well and truly to try, and true deliverance make, between our ſovereign lord the king and the priſoner whom they have in charge; and a true verdict to give, according to their evidence."

When the jury is ſworn, if it be a cauſe of any conſequence, the INDICTMENT is uſually opened, and the evidence marſhalled, examined, and enforced by the counſel for the crown or proſecution. But it is a ſettled rule at common law, that no counſel ſhall be allowed a priſoner upon his trial upon the general iſſue, in any capital crime, unleſs ſome point of law ſhall ariſe proper to be debated. A rule which (however it may be palliated under cover of that noble declaration of the law, when rightly underſtood, that the judge ſhall be counſel for the priſoner; that is, ſhall ſee that the proceedings againſt him are legal and ſtrictly regular) ſeems to be not at all of a piece with the reſt of the humane treatment of priſoners by the Engliſh law. For upon what face of reaſon can that aſſiſtance be denied to ſave the life of a man, which yet is allowed him in proſecutions for every petty treſpaſs? Nor indeed is it, ſtrictly ſpeaking, a part of our ancient law; for the Mirrour, having obſerved the neceſſity of counſel in civil ſuits, "who know how to forward and defend the cauſe by the rules of law, and cuſtoms of the realm," immediately afterwards ſubjoins, "and more neceſſary are they for defence upon indictments and appeals of felony, than upon other venial cauſes." And, to ſay the truth, the judges themſelves are ſo ſenſible of this defect in our modern practice, that they ſeldom ſcruple to allow a priſoner counſel to ſtand by him at the bar, and to inſtruct him what queſtions to aſk, or even to aſk queſtions for him, with regard to matters of fact; for as to matters of law ariſing on the trial, they are entitled to the aſſiſtance of counſel. But ſtill this is a matter of too much importance to be left to the good pleaſure of any judge, and is worthy the interpoſition of the legiſlature; which has ſhown its inclination to indulge priſoners with this reaſonable aſſiſtance, by enacting, in ſtatute 7 W. III. c. 3. that perſons indicted for ſuch high-treaſon as works a corruption of the blood or miſpriſonment thereof (except treaſon in counterfeiting the king's coins or ſeals), may make their full defence by counſel, not exceeding two, to be named by the priſoner, and aſſigned by the court or judge; and this indulgence, by ſtatute 20 Geo. II. c. 30. is extended to parliamentary impeachments for high-treaſon, which were excepted in the former act.

When the evidence on both ſides is cloſed, the jury cannot be diſcharged (unleſs in caſes of evident neceſſity) till they have given in their VERDICT. If they find the priſoner not guilty, he is then for ever quit and diſcharged of the accuſation, except he be appealed of felony within the time limited by law. And upon ſuch his acquittal, or diſcharge for want of proſecution, he ſhall be immediately ſet at large without payment of any fee to the gaoler. But if the jury find him guilty, he is then ſaid to be convicted of the crime whereof he ſtands indicted. See the article CONVICTION; and, ſubſequent thereto, the articles JUDGEMENT, ATTAINDER, FORFEITURE, EXECUTION, alſo *Benefit of CLERGY*, REPRIEVE, PARDON.

TRIAL, in *Scotland*. See *Scots LAW*.

TRIANDRIA (from τρεις "three," and ανηρ "a man or huſband)," the name of the third claſs in Linnæus's ſexual ſyſtem, conſiſting of plants with hermaphrodite flowers, which have three ſtamina or male organs.

TRIANGLE, in *Geometry*, a figure of three ſides and three angles.

TRIBE, in antiquity, a certain quantity or number of perſons, when a diviſion was made of a city or people into quarters or diſtricts.

TRIBRACHYS, in *Ancient Poetry*, a foot conſiſting of three ſyllables, and theſe all ſhort; as, *melius*.

TRIBUNAL, in general, denotes the ſeat of a judge, called in our courts *bench*.

TRIBUNE, among the ancient Romans, a magiſtrate choſen out of the commons, to protect them againſt the oppreſſions of the great, and to defend the liberty of the people againſt the attempts of the ſenate and conſuls.

The tribunes of the people were firſt eſtabliſhed in the year of the Rome 259. The firſt deſign of their creation was to ſhelter the people from the cruelty of uſurers, and to engage them to quit the Aventine mount, whither they had retired in diſpleaſure.

Their number at firſt was but two; but the next year, under the conſulate of A. Poſthumius Aruncius and Caſſius Viſcellinus, there were three more added; and this number of five was afterwards increaſed by L. Trebonius to ten.

Military TRIBUNE, an officer in the Roman army, commander in chief over a body of forces, particularly the diviſion of a legion; much the ſame with our colonel, or the French maitre de camp.

TRIBUTARY, one who pays tribute to another in order to live in peace with or ſhare in his protection.

TRIBUTE, a tax or impoſt which one prince or ſtate is obliged to pay to another as a token of dependence, or in virtue of a treaty, and as a purchaſe of peace.

TRICEPS, in *Anatomy*. See there, *Tables of the MUSCLES*.

TRICHECUS, WALRUS; a genus of aquatic animals belonging to the claſs of *mammalia*, and order of *bruta*. See MAMMALIA *Index*.

TRICHOMANES, a genus of plants belonging to the claſs of *cryptogamia*, and order of *filices*. See BOTANY *Index*.

TRICOCCEÆ (τρεις "three," and κοκκος "a grain"), the name of the 38th order in Linnæus's Fragments of a Natural Method, conſiſting of plants with a ſingle three-cornered capſule, having three cells, or internal diviſions, each containing a ſingle ſeed. See BOTANY.

TRICOSANTHES, a genus of plants belonging to the claſs of *monœcia*, and in the natural ſyſtem ranging under the 34th order, *Cucurbitaceæ*. See BOTANY *Index*.

TRIDENT, an attribute of Neptune, being a kind of ſceptre which the painters and poets put into the hands of that god, in form of a ſpear or fork with three teeth; whence the word.

TRIENNIAL, an epithet applied chiefly to offices or employments which laſt for three years.

TRIENS, in antiquity, a copper money of the value of one-third of an *as*, which on one ſide bore a Janus's head, and on the other a water rat.

TRIENTALIS, CHICKWEED WINTER-GREEN, a genus of plants belonging to the claſs of *heptandria*, and in the natural ſyſtem ranging under the 20th order, *Rotaceæ*. See BOTANY *Index*.

TRIERS, or TREVES. See TREVES.

TRIFOLIUM, TREFOIL, or *Clover*, a genus of plants belonging to the claſs of *diadelphia*, and in the natural ſyſtem ranging under the 32d order *Papilionaceæ*. See BOTANY *Index*.

TRIGA, in antiquity, denotes a kind of car or chariot drawn by three horſes; whence the name.

TRIGLA, a genus of fiſhes belonging to the order of thoracici. See ICHTHYOLOGY *Index*.

TRIGLOCHIN, a genus of plants belonging to the claſs of *hexandria*, and in the natural ſyſtem ranging under the fifth order, *Tripetaloideæ*. See BOTANY *Index*.

TRIGLYPHS, in *Architecture*, a ſort of ornament repeated at equal intervals, in the Doric freeze.

Dialing TRIGON. See DIALING.

TRIGONALIS. See PILA.

TRIGONELLA, FENUGREEK, a genus of plants belonging to the claſs of *diadelphia*, and in the natural ſyſtem arranged under the 32d order, *Papilionaceæ*. See BOTANY *Index*.

TRIGONOMETRY.

Nature and Conſtruction of Trigonometrical Tables.

TRIGONOMETRY is the application of arithmetic to geometry. It conſiſts of two principal parts, viz. PLANE TRIGONOMETRY and SPHERICAL TRIGONOMETRY.

Plane trigonometry treats of the application of numbers to determine the relations of the ſides and angles of a plane triangle to one another.

Spherical trigonometry treats of the application of numbers in like manner to ſpherical triangles; the nature of theſe will be explained in the courſe of this article.

Both branches of the ſubject depend eſſentially upon certain numerical tables, the nature and conſtruction of which we ſhall now proceed to explain.

SECTION I.

NATURE AND CONSTRUCTION OF TRIGONOMETRICAL TABLES.

IT has been demonſtrated in GEOMETRY (Theor. 31. Sect. IV.) that any angles at the centre of a circle have to one another the ſame proportion as the arches intercepted between the lines which contain the angles. Hence it is eaſy to infer, that an angle at the centre of a circle has the ſame ratio to four right angles, that the arch intercepted between the lines which contain the angle has to the whole circumference. It alſo follows that we may employ arches of a circle as *meaſures* of angles, and thus the compariſon of angles is reduced to the compariſon of arches of a circle. From this principle we infer the conſiſtency of the firſt of the following ſeries of definitions.

DEFINITIONS.

I. If two ſtraight lines interſect one another in the centre of a circle, the arch of the circumference intercepted between them is called the *Meaſure* of the angle which they contain. Thus, (Plate DXXXVII. fig. 1.) the arch AB is the meaſure of the angle contained by the lines CA and and CH.

Plate DXXXVII. Fig. 1.

II. If the circumference of a circle be divided into 360 equal parts, each of theſe is called a *Degree;* and if a degree be divided into 60 equal parts, each of theſe is called a *Minute;* and if a minute be divided into 60 equal parts, each of theſe is called a *Second*, and ſo on; and as many degrees, minutes, ſeconds, &c. as are in any arch, ſo many degrees, minutes, ſeconds, &c. are ſaid to be in the angle meaſured by that arch.

COR. 1. Any arch is to the whole circumference of which it is a part, as the number of degrees and parts of a degree in it is to the number 360. And any angle is to four right angles as the number of degrees, &c. in the arch which is the meaſure of the angle to 360.

COR. 2. Hence alſo it appears that the arches which meaſure the ſame angle, whatever be the radii with which they are deſcribed, contain the ſame number of degrees and parts of a degree.

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The degrees, minutes, ſeconds, &c. contained in an arch or angle are commonly written thus, $23^{\circ}\ 29'\ 32''\ 20'''$, which expreſſion means 23 degrees 29 minutes 32 ſeconds and 20 thirds.

III. Two angles which make together two right angles, alſo two arches which make together a ſemicircle, are called the *Supplements* of one another.

IV. A ſtraight line BG drawn through B, one of the extremities of the arch AB, perpendicular to the diameter paſſing through the other extremity A, is called the *Sine* of the arch AC, or of the angle ACB, having arch AB for its meaſure.

COR. 1. The ſine of a quadrant or of a right angle is equal to the radius.

COR. 2. The ſine of an arch is half the chord of twice the arch.

V. The ſegment AG of the diameter intercepted between its extremity and the ſine BG is called the *Verſed Sine* of the arch AB, or of the angle ACB.

VI. A ſtraight line AH touching the circle at A one extremity of the arch AB, and meeting the diameter CB which paſſes through B the other extremity, is called the *Tangent* of the arch AB, or of the angle ACB.

COR. The tangent of half a right angle is equal to the radius.

VII. The ſtraight line CH between the centre and the extremity of the tangent AH is called the *Secant* of the arch AB or of the angle ACB.

COR. to Def. 4, 6, 7. The ſine, tangent, and ſecant of any angle ACB, are alſo the ſine, tangent, and ſecant of its ſupplement BCE. For by the definition, BG is the ſine of the angle BCE; and if BC be produced to meet the circle in I, then AH is the tangent and CH the ſecant of the angle ACI or BCE.

COR. to Def. 4, 5, 6, 7. The ſine, verſed ſine, tangent, and ſecant of an arch which is the meaſure of the angle ACB is to the ſine, verſed ſine, and ſecant of any other arch which is the meaſure of the ſame angle as the radius of the firſt arch is to the radius of the ſecond.

Let BG, fig. 2. be the ſine, AG the verſed ſine, AH the tangent, and CH the ſecant of the arch AB to the radius CA; and bg, ag, ah, ch the ſame things to the radius Ca. From ſimilar triangles $BG : bg :: BC : bC$; and becauſe $CG : Cg$ ($:: CB : Cb$) $:: CA : Ca$; therefore, by diviſion $AG : ag :: CA : Ca$. Alſo $AH : ah :: CH : Ch :: CA : Ca$.

Fig. 2.

Hence it appears that if tables be conſtructed exhibiting in numbers the ſines, tangents, and verſed ſines of certain angles to a given radius, they will exhibit the ratios of the ſines, tangents, and verſed ſines of the ſame angles to any radius whatever. In ſuch tables, which are called trigonometrical tables, the radius is either ſuppoſed 1, or ſome number in the ſeries 10, 100, 1000, &c,

Nature and Conſtruction of Trigonometrical Tables.

&c. The conſtruction and uſe of theſe tables we ſhall preſently explain.

VIII. The difference between any angle and a right angle, or between any arch and a quadrant, is called the *Complement* of that angle, or of that arch. Thus, if the angle ACD, fig. 1. be a right angle, and conſequently the arch AD, which is its meaſure, a quadrant, the angle BCD is the complement of the angle BCA, and the arch BD is the complement of the arch AB. Alſo the complement of the obtuſe angle BCE is BCD, its exceſs above a right angle; and the complement of the arch BDE is the arch BD.

Fig. 1.

IX. The ſine, tangent, or ſecant of the complement of any angle is called the coſine, cotangent, or coſecant of that angle. Thus, ſuppoſing the angle ACD to be a right angle, then BF=CG, the ſine of the angle BCD, is the coſine of the angle BCA; DK, the tangent of the angle BCD, is the cotangent of the angle BCA, and CK, the ſecant of the angle BCD, is the coſecant of the angle BCA.

The following properties of the lines which have been defined flow immediately from their poſition.

1. The ſum of the ſquares of the ſine and coſine of any angle is equal to the ſquare of the radius. For, in the right-angled triangle BGC, $BC^2 = BG^2 + GC^2$, (GEOMETRY, Sect. IV. theor. 13.) Now BG is the ſine, and CG=BF is the coſine of the angle BCA.

2. The radius is a mean proportional between the tangent of any angle and its cotangent, or tan. ACB× cot. ACB=rad.^{2}. For ſince DK, CA are parallel, the angles DKC, HCA are equal; now CDK, CAH are right angles, therefore the triangles CDK, HCA are ſimilar, and therefore AH : AC :: CD or AC : DK, and $AC^2 = AH \times DK$.

3. The radius is a mean proportional between the coſine and ſecant of any angle. Or coſ. ACB×ſec.ACB =rad^2. For the triangles CGB, CAH are ſimilar; therefore CG : CB or CA :: CA : CH.

4. The tangent of an arch is a fourth proportional to its coſine, its ſine and the radius, or tan. ACB = $\frac{\text{ſin. ACB}}{\text{coſ. ACB}} \times \text{rad.}$ For, from ſimilar triangles CG : GB :: CA : AH.

Trigonometrical tables uſually exhibit the ſines, tangents, and ſecants of all angles which can be expreſſed by an exact number of degrees and minutes from 1 minute to 90 degrees, or a right angle. Theſe may be computed in various ways, the moſt elementary is to calculate them by the help of principles deducible immediately from the elements of geometry.

It has been demonſtrated in GEOMETRY, (Sect. V. prob. 22.) that the chord of one-ſixth of the circumference, or an arch of 60°, is equal to the radius; therefore, if BD be an arch of 30°, its ſine BF will be half the radius (cor. 2. def. 4.). Let us ſuppoſe the radius to be expreſſed by unity, or 1, then ſin. $30^\circ = \frac{1}{2}$; now ſince a being put for any arch, $\text{coſ.}^2 a + \text{ſin.}^2 a = \text{rad.}^2$ (where by $\text{coſ.}^2 a$ is meant the ſquare of the number expreſſing the coſine of the arch a, &c.) and as $\text{ſin.}^2 30^\circ = \frac{1}{4}$, therefore $\text{coſ.}^2 30^\circ = 1 - \frac{1}{4} = \frac{3}{4}$, &c. Coſ. $30^\circ = \frac{1}{2}\sqrt{3} = .8660254038$.

It has been demonſtrated in the arithmetic of ſines (ALGEBRA, § 356.) that $2\,\text{coſ.}^2 a = 1 + \text{coſ.}\ 2a$; hence we have the following formula for finding the coſine of an arch, having given the coſine of its double; coſ. $a = \sqrt{\frac{1 + \text{coſ.}\ 2a}{2}}$. By this formula from the coſine of 30° we may find that of 15°, and again from coſ. 15° we may find coſ. 7° 30′, and proceeding in this way we may find the coſines of 3° 45′, 1° 52′ 30″, and ſo on, till after 11 biſections the coſine of 52″ 44‴ 3^{iv} 45^{v} is found; we may then find the ſine of this arch by the formula ſin. $a = \sqrt{(1 - \text{coſ.}^2 a)}$. Now, as from the nature of a circle the ratio of an arch to its ſine approaches continually to that of equality, when the arch is continually diminiſhed, it follows that the ſines of very ſmall arches will be very nearly to one another as the arches themſelves: Therefore, as 52″ 44‴ 3^{iv} 45^{v} to 1′ ſo is the ſine of the former arch to the ſine of the latter. By performing all the calculations which we have here indicated, it will be found that the ſine of 1′ is .0002908882.

Nature and Conſtruction of Trigonometrical Tables.

It has been ſhewn in the arithmetic of ſines (ALGEBRA, § 355.) that a and b being put for any two arches, ſin. $(a+b) = 2$ coſ. b ſin. a — ſin $(a-b)$, hence putting 1′ for b, and 1′, 2′, 3′, &c. ſucceſſively for a, we have,

ſin. 2′=2 coſ. 1′×ſin. 1′,
ſin. 3′=2 coſ. 1′×ſin. 2′—ſin. 1′,
ſin. 4′=2 coſ. 1′×ſin. 3′—ſin. 2′,
&c.

In this way the ſines for every minute of the quadrant may be computed, and as the multiplier coſ. 1′ remains always the ſame, the calculation is eaſy. If inſtead of 1′, the common difference of the ſeries of arches were any other angle, the very ſame formula would apply.

The ſines, and conſequently the coſines of any number of arches being ſuppoſed found, their tangents may be found by conſidering that tan. $a = \frac{\text{ſin.}\ a}{\text{coſ.}\ a}$; and their ſecants from the formula ſec. $a = \frac{1}{\text{coſ.}\ a}$.

We have here very briefly indicated the manner of conſtructing the trigonometrical *canon*, as it is ſometimes called. There are, however, various properties of ſines, tangents, &c. which greatly facilitate the actual calculation of the numbers, theſe the reader will find detailed in ALGEBRA, Sect. XXV. which treats expreſly of the *Arithmetic of Sines*.

The moſt expeditious mode of computing the ſine or coſine of a ſingle angle is by means of infinite ſeries: The inveſtigation of theſe is given in FLUXIONS, § 70.; and it is there ſhewn that if a denote any arch, then, the radius being expreſſed by 1,

$$\text{ſin.}\ a = a - \frac{a^3}{1\cdot 2\cdot 3} + \frac{a^5}{1\cdot 2\cdot 3\cdot 4\cdot 5} - \&\text{c.}$$

$$\text{coſ.}\ a = 1 - \frac{a^2}{1\cdot 2} + \frac{a^4}{1\cdot 2\cdot 3\cdot 4} - \&\text{c.}$$

To apply theſe we muſt have the arch expreſſed in parts of the radius, which requires that we know the proportion of the diameter of the circle to its circumference. We have inveſtigated this proportion in GEOMETRY, Prop. 6. Sect. vi.; alſo in FLUXIONS, § 137.; and ſubſequently in the article entitled SQUARING THE CIRCLE.

From theſe ſeries others may be found which ſhall expreſs the tangent and ſecant. Thus becauſe tan.

Nature and Conſtruction of Trigonometrical Tables.

$a=\frac{\text{ſin. } a}{\text{coſ. } a}$, we get, after dividing the ſeries for the ſine by that for the coſine,

$$\text{tan. } a=a+\frac{a^3}{3}+\frac{2a^5}{15}+\frac{17a^7}{315}+\&\text{c.}$$

And in like manner, dividing unity by the ſeries for coſ. a, becauſe ſec. $a=\frac{1}{\text{coſ. } a}$, we get

$$\text{ſec. } a=1+\frac{a^2}{2}+\frac{5a^4}{24}+\frac{61a^6}{720}+\&\text{c.}$$

We ſhall conclude what we propoſed to ſay on the conſtruction of the tables, by referring ſuch of our readers as wiſh for more extenſive information on this ſubject to Dr Hutton's Introduction to his excellent Mathematical tables; alſo to the treatiſes which treat expreſsly of trigonometry, among which are thoſe of *Emerſon*, *Simpſon*, *Bonnycaſtle*, *Cagnoli*, *Mauduit*, *Lacroix*, *Legendre*. In particular, we refer to an excellent treatiſe on the ſubject by *Mr R. Woodhouſe* of Caius college, Cambridge.

Deſcription of the Table of Logarithmic Sines, &c.

That trigonometrical tables may be extenſively uſeful, they ought to contain not only the ſine, tangent, and ſecant to every minute of the quadrant, but alſo the logarithms of theſe numbers; and theſe are given in Dr Hutton's Mathematical Tables, a work which we have already mentioned; as, however, the ſines, &c. or the *natural* ſines, &c. as they are called, are much leſs frequently wanted than their logarithms, we have only given a table of the latter. See LOGARITHMS.

This table contains the logarithms of the ſines and tangents, or the *logarithmic ſines* and *tangents*, to every minute of the quadrant, the degrees at top and minutes deſcending down the left-hand ſide, as far as 45°, and from thence returning with the degrees at the bottom and the minutes aſcending by the right hand ſide to 90°, in ſuch a manner that any arch on the one ſide is in the ſame line with its complement on the other, the reſpective ſines, coſines, tangents, and cotangents, being in the ſame line with the minutes, and on the columns figured with their reſpective names at top when the degrees are at top, but at the bottom when the degrees are at the bottom. The differences of the ſines and coſines are placed in columns to the right-hand, marked D; and the differences of the tangents and cotangents are placed in a column between them, each difference belonging equally to the columns on both ſides of it. Alſo each differential number is ſet oppoſite the ſpace between the numbers whoſe difference it is. All this will be evident by inſpecting the table itſelf.

There are no logarithmic ſecants in the table, but theſe are eaſily had from the coſines; for ſince ſec. $a=\frac{\text{rad.}^2}{\text{coſ. } a}$, therefore, log. ſec. $a=2$ log. rad.—log. coſ. a; now log. rad. $=10$, therefore the log. ſecant of any arch is had by ſubtracting its log. coſine from 20.

The log. ſine, log. tangent, or log. ſecant of any angle is expreſſed by the ſame numbers as the log. ſine, log. tangent, or log. ſecant of its ſupplement; therefore, when an angle exceeds 90°, ſubtract it from 180° and take the log. ſine, &c. of the remainder for that of the angle.

To find the log. ſine of any angle expreſſed by degrees and minutes. If the angle be leſs than 45°, look for the number of degrees at the top, and oppoſite to the minutes on the left hand will be found the ſine required; thus the log. ſine of 8° 10′ is 9.15245. But if the angle be 45° or more than 45°, look for the degrees at the bottom and the minutes on the right hand, and oppoſite will be found the log. ſine required. Thus the log. ſine of 58° 12′ is 9.92936. The very ſame directions apply for the coſine, tangent, and cotangent; and from what has been ſaid, the manner of finding the angle to degrees and minutes, having given its ſine, &c. muſt be obvious.

If the angle conſiſts of degrees, minutes, and ſeconds, find the ſine or tangent to the degrees and minutes, and add to this a proportional part of the difference given in the column of differences for the ſeconds, obſerving that the whole difference correſponds to 1′ or 60″. Thus to find the log. ſine of 30° 23′ 28″; firſt the ſine of 30° 23′ is 9.70396. The difference is 21. As 60″ : 28″ :: 21 : $\frac{28\times21}{60}=10$ nearly, the part of the difference to be added, therefore the ſine of 30° 23′ 28″ is 9.70406.

On the contrary, let it be required to find the angle correſponding to the tangent 10.14152.

The next leſs tangent in the table is 10.14140, which correſponds to 54° 10′; the difference between the propoſed tangent and next leſs is 12; and the difference between the next leſs and next greater, as given in the table, is 26; therefore, 26 : 12 :: 60″ : $\frac{12\times60}{26}$: 28″ nearly, hence the angle correſponding to the propoſed log. tangent is 54° 10′ 28″.

SECTION II.

PLANE TRIGONOMETRY.

THE following propoſitions expreſs as many of the properties of plane triangles as are eſſentially neceſſary in plane trigonometry.

THEOR. I.

In a right-angled plane triangle, as the hypothenuſe is to either of the ſides, ſo is the radius to the ſine of the angle oppoſite to that ſide; and as either of the ſides to the other ſide, ſo is the radius to the tangent of the angle oppoſite to that ſide.

Let ABC be a right-angled plane triangle (fig. 3.), of which AC is the hypothenuſe. On A as a centre with any radius, deſcribe the arch DE; draw EG at right angles to AB, and draw DF touching the circle at D, and meeting AC in F. Then EG is the ſine of the angle A to the radius AD or AE, and DF is its tangent.

Fig. 3.

The triangles AGE, ADF are manifeſtly ſimilar to the triangle ABC. Therefore AC : CB :: AE : EG; that is, AC : CB :: rad : ſin. A.

Again,

Again, AB : BC : : AD : DF; that is AB : BC : : rad. : tan. A.

COR. In a right-angled triangle, as the hypothenuſe to either of the ſides, ſo is the ſecant of the acute angle adjacent to that ſide to the radius. For AF is the ſecant of the angle A to the radius AD; and AC : AB :: AF : AD, that is, AC : AB :: ſec. A : rad.

Note. This propoſition is moſt eaſily remembered when ſtated thus. *If in a right-angled triangle the hypothenuſe be made the radius, the ſides become the ſines of the oppoſite angles; and if one of the ſides be made the radius, the other ſide becomes the tangent of the oppoſite angle, and the hypothenuſe its ſecant.*

THEOR. II.

The ſides of a plane triangle are to one another as the ſines of the oppoſite angles.

Fig. 4. From B any angle of the triangle ABC (fig. 4.), draw BD perpendicular to AC. Then, by laſt theorem,

AB : BD :: rad. : ſin. A,
alſo BD : BC :: ſin. C : rad.

therefore *ex equo* inverſely (GEOMETRY, Sect. III. Theor. 7.), AB : BC :: ſin. C : ſin. A.

THEOR. III.

The ſum of any two ſides of a triangle is to their difference as the tangent of half the ſum of the angles oppoſite to theſe ſides to the tangent of half their difference.

Fig. 5. Let ABC, fig. 5. be a triangle; AB+BC : AB—BC :: tan. $\frac{1}{2}$($\angle$BCA+$\angle$BAC) : tan. $\frac{1}{2}$($\angle$BCA—$\angle$BAC).

In AB produced take BE=BC, and on B as a centre with BC or BE as a radius, deſcribe the ſemicircle ECF meeting AC in D; join BD, CF, and CE, and from F draw FG parallel to AC, meeting CE in G.

Becauſe the angles CFE, CBE, ſtand on the ſame arch CE, and the former is at the circumference of the circle, and the latter at the centre; therefore, the angle CFE is half the angle CBE (GEOMETRY, Sect. II. Theor. XIV.); but the angle CBE is the ſum of the angles BAC, BCA (GEOMETRY, Sect. I. Theor. XXIII.); therefore the angle CFE is half the ſum of the angles BCA, BAC.

Becauſe the angle BDC is the ſum of the angles BAC, ABD, therefore the angle ABD is the difference between the angles BDC, BAD; but ſince BD=BC, the angle BDC is equal to BCD or BCA, therefore ABD is the difference of the angles BCA, BAC; but ABD, or FBD, being an angle at the centre of the circle, is double the angle FCD at the circumference, which laſt is equal to the alternate angle CFG; therefore the angle CFG is half the difference of the angles BCA, BAC.

Becauſe CE is manifeſtly the tangent of the angle CFE to the radius CF and CG the tangent of the angle CFG to the ſame radius; therefore CE : CG :: tan. CFE : tan. CFG. that is, CE : CG :: tan. $\frac{1}{2}$(BCA+BAC) : tan. $\frac{1}{2}$(BCA—BAC); but becauſe FG is parallel to AC. CE : CG :: AE : AF, that is, CE : CG :: AB+BC : AB—BC. therefore AB+BC : AB—BC : tan. $\frac{1}{2}$(BCA+BAC) tan. $\frac{1}{2}$(BCA—BAC).

THEOR. IV.

If a perpendicular be drawn from any angle of a triangle to the oppoſite ſide or baſe; the ſum of the ſegments of the baſe is to the ſum of the other two ſides as the difference of theſe ſides to the difference of the ſegments of the baſe.

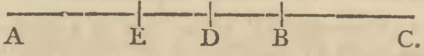
Fig. 6. LET ABC be a triangle (fig. 6.), and BD a perpendicular drawn to the baſe from the oppoſite angle; AD+DC : AB+BC :: AB—BC : AD—DC.

On, B as a centre with the radius BC, deſcribe a circle meeting AC in E, and AB in G, and the ſame line produced in F. Then AC : AF :: AG : AE; now AF=AB+BC, and AG=AB—BC, and becauſe ED=DC, AE (or AD—DE)=AD—DC, therefore AC : AB+BC :: AB—BC : AD—DC.

PROBLEM.

Having given the ſum of any two quantities and alſo their difference, to find each of the quantities.

SOLUTION. To half the ſum add half the difference of the quantities, and it will give the greater; and from half the ſum ſubtract half the difference, and it will give the leſs.



For let the greater of the two quantities be expreſſed by the line AB, and the leſs by BC; biſect AC in D, and take DE equal to DB, then AE=BC, and AB—BC=AB—AE=EB, and $\frac{1}{2}$(AB—BC)=DB; alſo $\frac{1}{2}$(AB+BC)=AD; now AB=AD+DB and BC=AD—DB, therefore the truth of the ſolution is evident.

In a plane triangle there are five diſtinct parts, which are ſo connected with one another, that any three of them being given, the remaining two may be found; theſe are, the three ſides and any two of the three angles; as to the remaining angle, that depends entirely upon the other two, and may be found from them independent of the ſides.

If one of the angles be a right angle, then the number of parts is reduced to four, and of theſe, any two being given, the remaining two may be found.

Solution of the Caſes of Right-angled Plane Triangles.

In right-angled triangles there are four caſes which may be reſolved by the firſt theorem.

Fig. 7. CASE 1. The hypothenuſe AC (fig. 7.) and an angle A being given, to find the ſides AB, BC about the right angle.

$$\text{SOLUTION.}\ \left\{\begin{array}{l}\text{Rad. : ſin. A :: AC : BC,}\\ \text{Rad. : coſ. A :: AC : AB.}\end{array}\right.$$

Example. In the triangle ABC, let the hypothenuſe AC be 144, and the angle A 39° 22′. Required the ſides AB and BC.

To find AB.		To find BC.	
	Logarithms.		Log.
Rad. - -	10.00000	Rad. -	10.00000
Sin. A 39° 22′	9.80228	Coſ. A 39° 22′	9.88824
AC 144	2.15836	AC 144	2.15836
BC=91.3	1.96064	AB=111.3	2.04660

Here the logarithms of the ſecond and third terms are added, and the logarithm of the firſt term ſubtracted or rejected from the ſum.

Case 2. A ſide AB, and an acute angle A (and conſequently the other angle C) being given, to find the hypothenuſe AC, and remaining ſide BC.

Solution. $\left\{\begin{array}{l}\text{Coſ. A : rad. :: AB : AC,}\\ \text{Rad. : tan. A :: AB : BC.}\end{array}\right.$

Example. In the triangle ABC are given AB 208, and the angle A 35° 16′, to find AC and BC.

To find AC.		To find BC.	
Coſ. A 35° 16′	9.91194	Rad. - -	10.00000
Rad. - - -	10.00000	Tan. A 35° 16′	9.84952
AB 208 -	2.31806	AB 208 -	2.31806
	12.31806	BC=147.1	2.16758
AC=254.7	2.40612		

Case 3. The hypothenuſe AC and a ſide AB being given, to find the angle A (and conſequently C) and the ſide BC.

Solution. $\left\{\begin{array}{l}\text{AC : AB :: rad. : coſ. A,}\\ \text{Rad. : ſin. A :: AC : BC.}\end{array}\right.$

Example. Let the hypothenuſe AC be 272, and the ſide AB 232. Required the angle A and the ſide BC.

To find A		To find BC.	
AC 272 -	2.43457	Rad. - -	10.00000
AB 232 -	2.36549	Sin. A 31° 28′	9.71767
Rad. - -	10.00000	AC 272 -	2.43457
	12.36549	BC 142 -	2.15224
Coſ. A=31° 28′	9.93092		

Case 4. The ſides AB and BC about the right angle being given, to find the angle A (and thence C) and the hypothenuſe AC.

Solution. $\left\{\begin{array}{l}\text{AB : BC : rad. : tan. A,}\\ \text{Coſ. A : rad. : AB : AC.}\end{array}\right.$

Example. Let the ſide AB be 186, the ſide BC 152. Required the angle A, and the hypothenuſe AC.

To find A.		To find AC.	
AB 186 -	2.26951	Coſ. A. 39° 15′	9.88896
BC 152 -	2.18184	Rad. - -	10.00000
Rad. - -	10.00000	AB 186 -	2.26951
	12.18184		12.26951
Tan. A=39° 15′	9.91233	AC=240.2	2.38055

Solution of the Caſes of Oblique-angled Triangles.

In oblique-angled triangles there are alſo four caſes, which, with their ſolutions, are as follows.

Fig. 8.

Case 1. Two angles A and B, and a ſide AB being given, to find the other ſides AC, BC.

Solution. Firſt ſubtract the ſum of the angles A and B from 180°, and the remainder is the angle C; then AC and BC are to be found from theſe proportions.

Sin. C : Sin. B :: AB : AC,
Sin. C : Sin. A :: AB : BC.

The truth of this ſolution is obvious from Theor. II.

Example. In the triangle ABC are given the ſide AB=266, the angle A 38° 40′, the angle B 72° 16′; to find the ſides AC and BC.

Firſt, A+B=110° 56′, and 180°—110° 56′=69° 4′=C.

Sin. C 69° 4′	9.97035	Sin. C 69° 4′	9.97035
Sin. B 72° 16′	9.97886	Sin. A 38° 40′	9.79573
AB 266 -	2.42488	AB 266 -	2.42488
	12.40374		12.22061
AC=271.3	2.43339	BC=177.9	2.25026

Case 2. Two ſides AC, CB (fig. 9.), and the angle A oppoſite to one of them, being given; to find the other angles B, C, and alſo the other ſide AB.

Fig. 9.

Solution. The angle B is found by this proportion.

CB : AC :: ſin. A : ſin. B.

When CB is leſs than CA, the angle B admits of two values, one of which is the ſupplement of the other; becauſe, correſponding to the ſame value of the ſide AC, and the angle A, the ſide BC may evidently have two diſtinct poſitions, viz. CB, C*b*. The angle CBA and its ſupplement C*b*A being found, the angle ACB, alſo the angle AC*b* may be found, by ſubtracting the ſum of the two known angles from 180°, and then AB and A*b* may be found by theſe proportions.

Sin. A : Sin. ACB :: CB : AB,
Sin. A : Sin. AC*b* :: CB or C*b* : A*b*.

This is called the *ambiguous* caſe, on account of the angle B and the ſide AB having ſometimes two values.

This ſolution, like the laſt, is deduced from Theorem II.

Example. Suppoſe AC 225, BC 180, and the angle A 42° 20′; to find the remaining parts.

CB 180 - -	2.25527
AC 225 - -	2.35218
Sin. A 42° 20′ -	9.82830
	12.18048
Sin. ABC=57° 20 Or ſin. A*b*C=122 40	9.92521

In the triangle ACB we have now the ſide AC and the angles CAB, CBA, therefore the remaining angle ACB and ſide AB may be found by Caſe 1.; and the ſame is true of the triangle AC*b*.

Case 3. Two ſides CA, CB and the included angle C being given, to find the remaining angles B, A, and ſide AB.

Solution. Find AC + CB, the ſum of the ſides, and AC — CB their difference; alſo find the ſum of the angles A and B (that ſum is the ſupplement of C), and half that ſum; then half the difference of the angles will be got from this proportion. (See Theor. III.).

$$AC+CB : AC-CB :: \tan.\tfrac{1}{2}(B+A) : \tan.\tfrac{1}{2}(B-A).$$

Having now the ſum and difference of the angles B and A, the angles will be found by the rule given in the problem following Theor. IV.

The remaining ſide may be found by either of theſe proportions.

$$\text{Sin. } B : \text{ſin. } C :: AC : AB;\ \text{or ſin. } A : \text{ſin. } C :: BC : AB.$$

Example. Let AC be 128, CB 90, and the angle C 48° 12′. Required the remaining parts of the triangle.

AC + CB 218	-	2.33846
AC — CB 38	-	1.57978
tan. ½ (B+A) 65° 54′		10.34938
		11.92916
tan. ½ (B—A) 21° 17′		9.59070

Hence by the given rule in the above-mentioned problem, B=87° 11′, A=43° 37′. As we now know all the angles and two ſides, the remaining ſide may be found by Caſe 1.

Fig. 10. Case 4. The three ſides AB, BC and AC (fig. 10.) being given, to find the three angles A, B, C.

Solution. Let fall a perpendicular CD upon the greateſt of the three ſides from the oppoſite angle. Then find the difference between AD and DB by this proportion.

$$AB : AC+CB :: AC-CB : AD-DB.$$

The ſegments AD, DB may now be found ſeverally by the rule given for finding each of the quantities whoſe ſum and difference is given, and then the angles A and B may be found by the following proportions.

CA : AD :: rad. : coſ. A,
CB : BD :: rad. : coſ. B.

The angles A, B being found, C of courſe is known. The firſt part of this ſolution follows from Theor. IV. The latter part from Theor. I.

Example. Let AB be 125, AC 105, and BC 95. Required the angles.

In this caſe AC+BC=200, AC — BC=10, therefore we have

$$125 : 200 :: 10 : AD-DB=\frac{200\times 10}{125}=16.$$

Now AD+DB=125, therefore AD=70.5 DB=54.5.

To find A.			To find B.		
AC 105	-	2.02119	BC 95	-	1.97772
AD 70.5	-	1.84819	BD 54.5	-	1.73640
Rad.	-	10.00000	Rad.	-	10.00000
		11.84819			11.73640
Coſ. A 47° 49′		9.82700	Coſ. B 55°	-	9.75868

For the application of plane trigonometry, ſee MENSURATION, Sect. I.

SECTION III.

SPHERICAL TRIGONOMETRY.

Theor. I.

If a ſphere be cut by a plane through the centre, the ſection is a circle.

The truth of this propoſition is evident from the definition of a ſphere. See GEOMETRY, Sect. IX. Def. 3.

Definitions.

I. Any circle which is a ſection of a ſphere by a plane paſſing through its centre, is called a *great circle* of the ſphere.

Cor. All great circles of a ſphere are equal, and the centre of the ſphere is their common centre, and any two of them biſect one another.

II. The *pole* of a great circle of the ſphere is a point in the ſuperficies of the ſphere from which all ſtraight lines drawn to the circumference of the circle are equal.

III. A *ſpherical angle* is that which on the ſuperficies of a ſphere is contained by two arches of great circles, and is the ſame with the inclination of the planes of theſe great circles.

IV. A *ſpherical triangle* is a figure upon the ſuperficies of a ſphere comprehended by three arches of three great circles, each of which is leſs than a ſemicircle.

Theor. II.

The arch of a great circle between the pole and and the circumference of another circle is a quadrant.

Let ABC be a great circle, (fig. 11.) and D its pole; let the great circle ADC paſs through D, and let AEC be the common ſection of the planes of the two circles, which will paſs through E the centre of the circle; join DA, DC. Becauſe the chord DA is equal to the chord DC, (Def. 2.) the arch DA is equal to the arch DC; now ADC is a ſemicircle, therefore the arches AD and DC are quadrants. Fig. 11.

Cor. 1. If DE be drawn, the angle AED is a right angle, and DE being therefore at right angles to every line it meets with in the plane of the circle ABC, is at right angles to that plane. Therefore the ſtraight line drawn from the pole of any great circle to the centre of the ſphere is at right angles to the plane of that circle.

Cor. 2. The circle has two poles D, D′, one on each

each ſide of its plane, which are the extremities of a diameter of the ſphere perpendicular to the plane ABC.

THEOR. III.

A ſpherical angle is meaſured by the arch of a great circle intercepted between the great circles containing the angle, and having the angular point for its pole.

Fig. 12. Let AB, AC be two arches of great circles containing the ſpherical angle BAC; let BC be an arch of a great circle intercepted between them, and having A for its pole, and let BD, CD, AD be drawn to D the centre of the ſphere. The arches AB, AC are quadrants, (Theor. II.), and therefore the angles ADB, ADC right angles; therefore (GEOMETRY, Sect. VII. Def. 4.), the angle BDC (which is meaſured by the arch BC) is the inclination of the planes of the circles BDA, CDA, and is equal to the ſpherical angle BAC (Def. 3.).

COR. If AB, AC two arches of great circles meet in A, then A ſhall be the pole of a great circle paſſing through B and C.

THEOR. IV.

Two great circles whoſe planes are perpendicular paſs through each others poles.

Fig. 13. Let ACBD, AEBF be two great circles, the planes of which are at right angles to one another; from G the centre of the ſphere, draw GC in the plane ABCD perpendicular to AB, then GC is alſo perpendicular to the plane AEBF, (GEOMETRY, Sect. VII. Theor. 12.); therefore C is the pole of the circle AEBF, and if CG be produced to D, D is the other pole of the circle AEBF.

In the ſame manner, by drawing GE in the plane AEBF perpendicular to AB, and producing it to F, it is ſhewn that E and F are the poles of the circle ABCD.

COR. 1. If two great circles paſs through each others poles, their planes are perpendicular to one another.

COR. 2. If of two great circles the firſt paſſes through the poles of the ſecond, the ſecond alſo paſſes through the poles of the firſt.

THEOR. V.

If the angular points of any ſpherical triangle be made the poles of three great circles, another triangle will be formed by their interſections, ſuch, that the ſides of the one triangle will be reſpectively the ſupplements of the meaſures of the angles oppoſite to them in the other.

Fig. 14. Let the angular points of the triangle ABC be the poles of three great circles; which by their interſections form the three lunary ſurfaces DQ, FR, and EO; A being the pole of EF, B the pole of DF, and C the pole of ED. Then the triangle DEF which is common to three lunary ſurfaces will be in every reſpect ſupplemental to the triangle ABC.

For let each ſide of ABC be produced to meet the ſides that contain the angle oppoſite to it, in the triangle DEF; then, becauſe BC paſſes through the poles of ED, DF, ED, DF muſt alſo paſs through the poles of BC. (Theor. II. Cor. 2.). Therefore the points D, Q are the poles of BC. In like mannner R, F are the poles of AB, and E, O the poles of AC. Hence EL, FK are quadrants, (Theor. II.); and therefore EF is the ſupplement of KL, but ſince A is the pole of EF, KL is the meaſure of the angle at A; thus EF is the ſupplement of the meaſure of the angle at A. In like manner FD is the ſupplement of the meaſure of the angle at B, and DE the ſupplement of the meaſure of the angle at C.

Further, it will appear in the ſame manner that BC is the ſupplement of HM, the meaſure of the angle at D; that AB is the ſupplement of NK the meaſure of the angle at F; and that AC is the ſupplement of GL, the meaſure of the angle at E.

THEOR. VI.

If from any point E, which is not the pole of the great circle ABC, there be drawn arches of great circles EA, EK, EB, &c. the greateſt of theſe is EGA, which paſſes through G the pole of ABC, and EC the remainder of the ſemicircle is the leaſt, and of the other, EK, EB, &c. EK which is nearer to EA is greater than EB, which is more remote. Fig. 15.

Let AC be the common ſection of the planes of the great circles AEC, ABC; draw EH perpendicular to AC, which will be perpendicular to the plane of the circle ABC (GEOMETRY, Sect. VII. Theor. XII.) and join AE, KE, BE, KH, BH. Then of all the ſtraight lines drawn from H to the circumference, HA is the greateſt, HC the leaſt, and HK greater than HB: Therefore in the right-angled triangles EHA, EHK, EHB, EHC, which have the ſide EH common, EA is the greateſt hypothenuſe, EC the leaſt, and EK greater than EB, conſequently the arch EGA is the greateſt, EC the leaſt and EK greater than EB.

THEOR. VII.

Any two ſides of a ſpherical triangle are together greater than the third, and all the three ſides are together leſs than a circle.

Let ABC be a ſpherical triangle, let D be the centre of the ſphere, join DA, DB, DC. The ſolid angle at D is contained by three plane angles ADB, BDC, ADC, any two of which are greater than the third, (GEOMETRY, Sect. VII. Theor. XV.); and therefore any two of the arches AB, BC, AC which meaſure theſe angles muſt be greater than the third arch. Fig. 16.

To prove the ſecond part of the propoſition, produce the ſides AB, AC until they meet again in E; then ECA and EBA are ſemicircles; now CB is leſs than CE+EB, therefore CB+CA+BA is leſs than CE+EB+CA+BA, but theſe four arches make up two ſemicircles; therefore CB+CA+BA is leſs than a circle.

Theor. VIII.

If two ſides of a ſpherical triangle be equal, the angles oppoſite to them are equal, and converſely.

Fig. 17. In the triangle ABC, if the ſides AB, AC be equal, the angles ABC, ACB are alſo equal. If AB, AC be quadrants, ABC, ACB are right angles. If not, let the tangent to the ſide AB at B meet EA the line of common ſection of the planes AB, AC in F, and let the tangents to the baſe BC at its extremities meet each other in G; alſo, let FC, FG, EC, and EB be joined. Then the triangles FEB, FEC have FE common, EB=EC, and the angle AEB=AEC, therefore FB=FC, and the angle FCE=FBE a right angle: hence FC is a tangent, and the triangles FGB, GCF are mutually equilateral, therefore the angle FBG=FCG and conſequently the ſpherical angle ABC=ACB.

Again, if the angles ABC, ACB be equal, the ſide AB=AC. For if in fig. 14. the angle ABC be equal to ACB, the ſide DF of the ſupplemental triangle DEF will be equal to the ſide DE (Theor. V.); therefore the angle DEF=DFE, and conſequently in the triangle ABC, the ſide AC=AB by Theorem V.

Fig. 18.

Cor. In any triangle the greater angle is ſubtended by the greater ſide; and converſely. For if the angle ACB be greater than ABC (fig. 18.) let BCD=ABC, then BD=DC, and AB=AD+DC, which is greater than AC (Theor. VII.). The converſe is demonſtrated in the ſame manner as the like property of plane triangles, (Geometry, Sect. I. Theor. XIII.).

Theor. IX.

All the angles of a ſpherical triangle are together greater than two, and leſs than ſix right angles.

Fig. 14. In the triangle ABC (fig. 14.) the three angles are together leſs than ſix right angles, becauſe when added to the three exterior angles they only make ſix; and they are greater than two right angles, becauſe their meaſures GH, KL, MN, added to DE, EF, FD, are equal to three ſemicircles; and DE, EF, FD being leſs than two ſemicircles (Theor. VII.) GH, KL, MN muſt be greater than one.

Theor. X.

Any two angles of a ſpherical triangle are together greater, equal, or leſs than two right angles, according as the ſum of the oppoſite ſides is greater, equal, or leſs than a ſemicircle; and converſely.

Fig. 19. Let the ſides AB, AC (fig. 19.) of the ſpherical triangle ABC be produced to meet in D; then it is evident that according as the ſum of AB, BC is greater, equal, or leſs than the ſemicircle ABD, the ſide BC will be greater, equal, or leſs than BD; the angle D or A will be greater, equal, or leſs than BCD, and the ſum of the angles BAC, BCA greater, equal, or leſs than the ſum of BCA, BCD, which is two right angles.

Cor. According as half the ſum of any two ſides of a ſpherical triangle is greater, equal, or leſs than a quadrant, half the ſum of the oppoſite angles will be greater, equal, or leſs than a right angle.

Theor. XI.

In a right-angled triangle, according as either of the ſides about the right angle is greater, equal, or leſs than a quadrant, its oppoſite angle is greater, equal, or leſs than a right angle; and converſely.

Let ABC (fig. 20.) be a triangle right-angled at B, and let the ſides AB, BC be produced to meet in D; then, becauſe they paſs through each others poles, E the middle point of BAD will be the pole of BCD; let a great circle paſs through the points CE. The arch EC is a quadrant, and the angle ECB a right angle. Now it is plain, that according as AB is greater, equal, or leſs than the quadrant EB, the oppoſite angle ACB will be greater, equal, or leſs than the right angle ECB, and converſely. Fig. 20.

Cor. 1. If the two ſides be both greater, or both leſs than quadrants, the hypothenuſe will be leſs than a quadrant; but if the one be greater and the other leſs, the hypothenuſe will be greater than a quadrant, and converſely.

For in the triangles ABC, ADC, right-angled at B, D, in which the ſides AB, BC are leſs, and conſequently AD, DC greater than quadrants, the hypothenuſe AC is leſs than a quadrant, becauſe it is nearer to CB than the quadrant CE. But in the triangle *a*BC, of which the ſide *a*B is greater, and BC leſs than a quadrant, the hypothenuſe *a*C is greater than a quadrant, becauſe it is further from CB than CE is.

Cor. 2. In every ſpherical triangle, of which the two ſides are not both quadrants, if the perpendicular from the vertex fall within, the angles at the baſe will be both acute or both obtuſe; but if it fall without, the one will be obtuſe, and the other acute; and converſely.

Theor. XII.

In any right-angled ſpherical triangle, as radius is to the ſine of the hypothenuſe, ſo is the ſine of one of the oblique angles to the ſine of its oppoſite ſide.

Let ABC (fig. 21.) be a ſpherical triangle, having a right angle at B; and let AD, BD, CD be drawn to the centre of the ſphere. From C, in the plane DCA, let CE be drawn perpendicular to DA, and from E, in the plane DBA, draw EF perpendicular to the ſame line, and let CF be joined. Then becauſe DA is perpendicular to the two lines CE, EF, it is perpendicular to the plane CEF, and conſequently the plane CEF is perpendicular to the plane DBA; but the plane DCB is alſo perpendicular to DBA; therefore their line of common ſection CF is perpendicular to the ſame: Hence CFD, CFE are right angles. Now in the right-angled triangle CFE, rad. : CE :: ſin. E : CF; but the angle CEF, being the inclination of the planes DCA, DBA, is the ſame with the ſpherical angle CAB, CE is the ſine of AC, and CF the ſine of BC; therefore rad. : ſin. AC :: ſin. A : ſin. BC. Fig. 21.

Cor. 1. As radius to the coſine of either of the ſides, ſo is the coſine of the other to the coſine of the hypothenuſe.

Fig. 22. For let the great circle of which A is the pole, meet the three ſides in D, E, F; then F is the pole of AD; and applying this propoſition to the complemental triangle FCE, rad. : ſin. FC :: ſin. F : ſin. CE; that is, rad. : coſ. BC :: coſ. AB : coſ. AC.

Cor. 2. As radius to the coſine of one of the ſides, ſo is the ſine of its adjacent angle to the coſine of the other angle.

Theor. XIII.

In any right-angled triangle, as radius to the ſine of one of the ſides, ſo is the tangent of the adjacent angle to the tangent of the other ſide.

Fig. 23. From B let BE be drawn perpendicular to DA, and from E, EF alſo perpendicular to DA, in the plane DCA, to meet DC in F, and let BF be joined. It may be ſhown as in the preceding propoſition, that FB is perpendicular to the plane DBA; hence FB is the tangent of BC, and FBE is a right-angled triangle; therefore rad. : EB :: tan. E : FB; that is rad. : ſin. AB :: tan A : tan. BC.

Cor. 1. As radius to the coſine of the hypothenuſe, ſo is the tangent of one of the angles to the cotangent of the other. For, in the complemental triangle FCE, (fig. 22.) rad. : ſin. CE :: tan. C : tan. FE, that is, rad. : coſ. AC :: tan. C : cot. A, or, rad. : coſ. AC :: tan. A : cot. C.

Cor. 2. As radius is to the coſine of one of the angles, ſo is the tangent of the hypothenuſe to the tangent of the ſide adjacent to that angle.

For rad. : ſin. FE :: tan F : tan. CE; that is, rad. : coſ. A :: cot. AB : cot. AC, or rad. : coſ. A :: tan. AC : tan. AB.

Napier's Rule for Circular Parts.

Let the hypothenuſe, the two angles, and the complements of the two ſides of any right-angled ſpherical triangle be called the *five circular parts* of the triangle. Any one of theſe being conſidered as the *middle* part, let the two which are next to it be called the *adjacent* parts, and the remaining two the *oppoſite* parts. Then the two preceding theorems, with their corollaries, may be all expreſſed in one propoſition adapted to practice, as follows.

In any right-angled ſpherical triangle, the rectangle under radius, and the coſine of the middle part, is equal to the rectangle under the cotangents of the adjacent parts, or to the rectangle under the ſines of the oppoſite parts.

Fig. 24. Case 1. Let the hypothenuſe AC be the middle part.

Then, rad. : coſ. AC :: tan. C : cot. A (Theor. 13. Cor. 1.).

Therefore (rad. : tan. C ::) cot. C : rad. :: coſ. AC : cot. A.

And rad. : coſ. AB :: coſ. BC : coſ. AC (Theor. 12. Cor. 1.).

Case 2. Let the angle A be the middle part.

Then (Theor. 13. Cor. 2.) rad. : coſ. A :: tan. AC : tan. AB.

Therefore, (rad. : tan. AC ::) cot. AC : rad. :: coſ. A : tan. AB,

And (Theor. 12. Cor. 2.) rad. : coſ. BC :: ſin. C : coſ. A.

Case 3. Let the complement of the ſide AB be the middle part.

Then (Theor. 13.) rad. : ſin. AB :: tan. A : tan. BC.

Therefore (rad. : tan. A ::) cot. A : rad. :: ſin. AB : tan. BC.

And (Theor. 12.) rad. : ſin. AC :: ſin. C : ſin. AB.

We are indebted for the foregoing rule to Napier, the celebrated inventor of logarithms. It comprehends all the propoſitions which are neceſſary for the reſolution of right-angled triangles, and being eaſily remembered, is perhaps one of the happieſt inſtances of artificial memory that is known.

Theor. XIV.

In any ſpherical triangle, the ſines of the ſides are proportional to the ſines of the oppoſite angle.

This propoſition has been demonſtrated in the caſe of right-angled triangles. Let ABC be any oblique-angled triangle, divided into two right-angled triangles, ABD, CBD, by the perpendicular BD, falling from the vertex upon the baſe AC. In the former, the complement of BD being the middle part, rad. × ſin. BD = ſin. AB × ſin. A, (Napier's Rule). In the latter, the complement of BD being the middle part, rad. × ſin. BD = ſin. BC × ſin. C. Hence ſin. AB × ſin. A = ſin. BC × ſin. C, and ſin. AB : ſin. BC :: ſin. C : ſin. A. Fig. 25.

Cor. 1. The coſines of the two ſides are to one another directly as the coſines of the ſegments of the baſe. This is proved by making AB, BC the middle part.

Cor. 2. The tangents of the two ſides are to one another inverſely as the coſines of the vertical angles. This will follow from making the angles ABD, CBD the middle parts.

Lemma 1. *The ſum of the tangents of two arches is to their difference, as the rectangle under the ſine and coſine of half their ſum to the rectangle under the ſine and coſine of half their difference.*

For, putting a and b for any two arches, by the arithmetic of ſines (Algebra, § 353.),

$$\text{Sin. } a \text{ coſ. } b + \text{coſ. } a \text{ ſin. } b = \text{ſin. } (a+b).$$

Let each ſide of this equation be divided by coſ. a coſ. b, and we get

$$\frac{\text{ſin. } a}{\text{coſ. } a} + \frac{\text{ſin. } b}{\text{coſ. } b} = \frac{\text{ſin. } (a+b)}{\text{ſin. } a \text{ coſ. } b}$$

that is, $\text{tan. } a + \text{tan. } b = \dfrac{\text{ſin. } (a+b)}{\text{ſin. } a \text{ coſ. } b}$.

In like manner, from the formula ſin. $(a-b) =$ ſin. a coſ. b — coſ. a ſin. b, we get

$$\text{tan. } a - \text{tan. } b = \frac{\text{ſin. } (a-b)}{\text{ſin. } a \text{ coſ. } b}.$$

therefore tan. a + tan. b : tan. a — tan. b : ſin. $(a+b)$: ſin. $(a-b)$, and remarking that ſin. $(a+b) = 2$ ſin. $\frac{1}{2}(a+b)$,

$\frac{1}{2}(a+b)$ coſ. $\frac{1}{2}(a+b)$, and ſin. $(a-b) = 2$ ſin. $\frac{1}{2}(a-b)$ coſ. $\frac{1}{2}(a-b)$, (ALGEBRA, § 358) it follows that tan. a + tan. b : tan. a — tan. b :: ſin. $\frac{1}{2}(a+b)$ coſ. $\frac{1}{2}(a+b)$: ſin. $\frac{1}{2}(a-b)$ coſ. $\frac{1}{2}(a-b)$.

LEMMA 2. *The ſum of the ſines of two arches is to their difference, as the rectangle under the ſine of half the ſum and coſine of half the difference of theſe arches is to the rectangle under the ſine of half the difference and coſine of half the ſum.*

For it has been ſhown in the arithmetic of ſines (ALGEBRA, § 355), that

$$\text{Sin.}\ (p+q)+\text{ſin.}\ (p-q)=2\ \text{ſin.}\ p\ \text{coſ.}\ q,$$
$$\text{Sin.}\ (p+q)-\text{ſin.}\ (p-q)=2\ \text{coſ.}\ p\ \text{ſin.}\ q.$$

Let $p=\frac{1}{2}a+\frac{1}{2}b$, and $q=\frac{1}{2}a-\frac{1}{2}b$, ſo that $p+q$, $=a$ and $p-q=b$, then theſe formulas become

$$\text{Sin.}\ a+\text{ſin.}\ b=2\ \text{ſin.}\ \tfrac{1}{2}(a+b)\ \text{coſ.}\ \tfrac{1}{2}(a-b)$$
$$\text{Sin.}\ a-\text{ſin.}\ b=2\ \text{coſ.}\ \tfrac{1}{2}(a+b)\ \text{ſin.}\ \tfrac{1}{2}(a-b).$$

Therefore, ſin. a + ſin. b : ſin. a — ſin. b :: ſin. $\frac{1}{2}(a+b)$ coſ. $\frac{1}{2}(a-b)$: coſ. $\frac{1}{2}(a+b)$ ſin. $\frac{1}{2}(a-b)$.

LEMMA 3. *The ſum of the ſines of two arches is to their difference, as the tangent of half the ſum of theſe arches is to the tangent of half their difference.*

For, dividing the latter antecedent and conſequent of the proportion in the foregoing lemma by coſ. $\frac{1}{2}(a+b) \times$ coſ. $\frac{1}{2}(a-b)$, we have ſin. a + ſin. b : ſin. a — ſin. b :: $\frac{\text{ſin.}\ \frac{1}{2}(a+b)}{\text{coſ.}\ \frac{1}{2}(a+b)} : \frac{\text{ſin.}\ \frac{1}{2}(a-b)}{\text{coſ.}\ \frac{1}{2}(a-b)}$, that is, becauſe $\frac{\text{ſin.}}{\text{coſ.}}=$ tan. ſin. a + ſin. b : ſin. a — ſin. b :: tan. $\frac{1}{2}(a+b)$: tan. $\frac{1}{2}(a-b)$.

LEMMA 4. *The ſum of the coſines of two arches is to their difference, as the cotangent of half the ſum of theſe arches is to the tangent of half their difference.*

By Arithmetic of ſines (ALGEBRA, § 355.),

$$\text{coſ.}\ (p-q)+\text{coſ.}\ (p+q)=2\ \text{coſ.}\ p\ \text{coſ.}\ q,$$
$$\text{coſ.}\ (p-q)-\text{coſ.}\ (p+q)=2\ \text{ſin.}\ p\ \text{ſin.}\ q.$$

Let $p=\frac{1}{2}(b+a)$ and $q=\frac{1}{2}(b-a)$, then $p-q=a$ and $p+q=b$, and the two formulas become

$$\text{coſ.}\ a+\text{coſ.}\ b=2\ \text{coſ.}\ \tfrac{1}{2}(b+a)\ \text{coſ.}\ \tfrac{1}{2}(b-a),$$
$$\text{coſ.}\ a-\text{coſ.}\ b=2\ \text{ſin.}\ \tfrac{1}{2}(b+a)\ \text{ſin.}\ \tfrac{1}{2}(b-a);$$

Hence, coſ. a + coſ. b : coſ. a — coſ. b :: coſ. $\frac{1}{2}(b+a)$ coſ. $\frac{1}{2}(b-a)$: ſin. $\frac{1}{2}(b+a)$ ſin. $\frac{1}{2}(b-a)$;

and dividing the latter antecedent and conſequent by ſin. $\frac{1}{2}(b+a)$ coſ. $\frac{1}{2}(b-a)$,

$$\text{coſ.}\ a+\text{coſ.}\ b : \text{coſ.}\ a-\text{coſ.}\ b :: \frac{\text{coſ.}\ \frac{1}{2}(b+a)}{\text{ſin.}\ \frac{1}{2}(b+a)} : \frac{\text{ſin.}\ \frac{1}{2}(b-a)}{\text{coſ.}\ \frac{1}{2}(b-a)},$$

that is, becauſe $\frac{\text{coſ.}}{\text{ſin.}}=$ cot. and $\frac{\text{ſin.}}{\text{coſ.}}=$ tan. we have coſ. a + coſ. b : coſ. a — coſ. b :: cot. $\frac{1}{2}(b+a)$: tan. $\frac{1}{2}(b-a)$.

Fig. 26.

IN the demonſtration of the remaining theorems, we ſhall put A, B for the angles A and B at the baſe of the ſpherical triangle ACB (fig. 26), a and b for the ſides oppoſite to theſe angles, p and q for the ſegments of the baſe BD, AD made by the perpendicular arch CD, P and Q for the vertical angles BCD, ACD; we ſhall alſo put s for $\frac{1}{2}(a+b)$, d for $\frac{1}{2}(a-b)$, s' for $\frac{1}{2}(p+q)$, d' for $\frac{1}{2}(p-q)$, S for $\frac{1}{2}(A+B)$, D for $\frac{1}{2}(A-B)$, S′ for $\frac{1}{2}(P+Q)$, and D′ for $\frac{1}{2}(P-Q)$.

THEOR. XV.

In any ſpherical triangle, the tangent of half the ſum of the ſegments of the baſe is to the tangent of half the ſum of the two ſides, as the tangent of half their difference to the tangent of half the difference of the ſegments of the baſe.

For by Theor. XIV. Cor. 1. coſ. a : coſ. b :: coſ. p : coſ. q; therefore, coſ. a + coſ. b : coſ. a — coſ. b :: coſ. p + coſ. q : coſ. p — coſ. q, hence (Lemma 4.) cot. s : tan. d :: cot. s' : tan. d', or cot. s : cot. s' :: tan. d : tan. d'; but cot. s : cot. s' :: tan. s' : tan. s, therefore, tan. s' : tan. s :: tan. d : tan. d'. This propoſition expreſſed in words at length is the theorem to be demonſtrated.

THEOR. XVI.

The cotangent of half the ſum of the vertical angles and the tangent of half their difference, or the cotangent of half their difference and the tangent of half their ſum, according as the perpendiculars fall within or without, are reciprocally proportional to the tangents of half the ſum and half the difference of the angles at the baſe.

For, taking the caſe in which the perpendicular CD (fig. 27.) falls within, let EFG be the ſupplemental triangle, let the arches GE, GF meet again in L, and produce CA, CB to meet EF in H and K. Becauſe G and L are the poles of AB, the perpendicular CD, if produced, will paſs through G and L; let it meet EF in I; then, becauſe C is the pole of EF, the arch GCI is perpendicular to EF, and ſince E is the pole of BC, KE=a quadrant=FH, and EH=KF, and IF—IE=IK—IH. In the triangle LEF, by the preceding propoſition, tan. $\frac{1}{2}$(FI+IE) : tan. $\frac{1}{2}$(FL+LE) :: tan. $\frac{1}{2}$(FL—LE) : tan. $\frac{1}{2}$(FI—IE) or tan. $\frac{1}{2}$(KI—IH). Now FI+IE, or FE, being the ſupplement of C, (Theor. 5.), tan. $\frac{1}{2}$ FE=cot. $\frac{1}{2}$ C; and FL, LE being the ſupplements of FG and GE, FL and LE are the meaſures of the angles A, B; moreover, IK, IH are the meaſures of the angles BCD, ACD, therefore, cot. $\frac{1}{2}$ C, or cot. $\frac{1}{2}$(P+Q) : tan. $\frac{1}{2}$(A+B) : tan. $\frac{1}{2}$(A—B) : tan. $\frac{1}{2}$(P—Q). In the very ſame way it may be proved, when the perpendicular falls without the triangle, that cot. $\frac{1}{2}$(P—Q) : tan. $\frac{1}{2}$(A+B) :: tan. $\frac{1}{2}$(A—B) : tan $\frac{1}{2}$(P+Q). Fig. 27.

THEOR. XVII.

In any ſpherical triangle, the ſine of half the ſum of the ſides is to the ſine of half their difference, as the cotangent of half the vertical angle to the tangent of half the difference of the angles at the baſe.

For ſince tan. a : tan. b :: coſ. Q : coſ. P, therefore, tan.

tan. a + tan. b : tan. a — tan b :: coſ. Q + coſ. P : coſ. Q — coſ. P ; hence, by Lemma 2 and 4.

ſin. s coſ. s : ſin. d coſ. d :: cot. S' : tan. D' . . . (1).

Again, becauſe (by Theor. XIV.) ſin. a : ſin. b :: ſin. A : ſin. B, therefore, ſin. a + ſin. b : ſin. a — ſin. b :: ſin. A + ſin. B : ſin. A — ſin. B ; hence, (by Lemma 2. and 3.).

ſin. s coſ. d : ſin. d coſ. s :: tan. S : tan. D . . . (2).

Taking now the product of the correſponding terms of the proportions (1) and (2), and rejecting the factor coſ. s coſ. d, which is common to the firſt antecedent and conſequent of the reſulting proportion, we have,

ſin.^{2} s : ſin.^{2} d :: cot. S' tan. S : tan D' tan. D.

But ſince by Theor. XVI. tan. S : tan. D' :: cot. S' : tan. D, therefore cot. S' tan. S : tan. D' tan. D :: cot.^{2} S' : tan.^{2} D ; therefore, ſin.^{2} s : ſin.^{2} d :: cot.^{2} S' : tan.^{2} D, and ſin. s : ſin. d :: cot. S' : tan. D, this proportion when expreſſed in words is the proportion to be demonſtrated.

THEOR. XVIII.

In any ſpherical triangle, the coſine of half the ſum of the two ſides is to the coſine of half their difference, as the cotangent of half the vertical angle to the tangent of half the ſum of the angles at the baſe.

For it has been proved in laſt theorem that

ſin. s coſ. s : ſin. d coſ. d :: cot. S' : tan. D'
ſin. s coſ. d : ſin. d coſ. s :: tan. S : tan. D ;

therefore, dividing the terms of the firſt of theſe two proportions by the correſponding terms of the ſecond, we get,

$$\frac{\text{coſ. } s}{\text{coſ. } d} : \frac{\text{coſ. } d}{\text{coſ. } s} :: \frac{\text{cot. } S'}{\text{tan. } S} : \frac{\text{tan. } D'}{\text{tan. } D}.$$

Hence, multiplying the firſt and ſecond terms by coſ. s × coſ. d, and the third and fourth by tan. S tan. D, we have,

coſ.^{2} s : coſ.^{2} d :: cot. S' tan. D : tan. S tan. D'.

But ſince by Theor. XVI. tan. D : tan. D' :: cot. S' : tan. S, therefore, cot. S' tan. D : tan. S tan. D' :: cot.^{2} S' : tan.^{2} S ; therefore, coſ.^{2} s : coſ.^{2} d :: cot.^{2} S' : tan.^{2} S, and coſ. s : coſ. d :: cot. S' : tan. S.

THEOR. XIX.

In any ſpherical triangle, the ſine of half the ſum of the angles at the baſe is to the ſine of half their difference, as the tangent of half the baſe to the tangent of half the difference of the two ſides.

Fig. 27. For the ſame conſtruction being made as in Theor. XVI. in the triangle ELF (fig. 27.) ſin. $\frac{1}{2}$ (FL + LE) : ſin. $\frac{1}{2}$ (FL — LE) :: cot. $\frac{1}{2}$ L : tan. $\frac{1}{2}$ (E — F) (Theor. XVII.) ; but EFG being the ſupplemental triangle of ABC, LF and LE are the meaſures of A and B, L is the ſupplement of AB, and LFE, LEF are the meaſures of the ſides AC, BC (Theor. V.) ; therefore ſin. $\frac{1}{2}$ (A + B) : ſin. $\frac{1}{2}$ (A — B) :: tan. $\frac{1}{2}$ AB : tan. $\frac{1}{2}$ (BC — AC).

THEOR. XX.

In any ſpherical triangle, the coſine of half the ſum of the angles at the baſe is to the coſine of half their difference, as the tangent of half the baſe to the tangent of half the ſum of the two ſides.

FOR in the triangle ELF, coſ. $\frac{1}{2}$ (LF + LE) : coſ. $\frac{1}{2}$ (LF — LE) :: cot. $\frac{1}{2}$ L : tan. $\frac{1}{2}$ (E + F) (Th. XVIII.) that is, becauſe of the relation of the triangle FLE to ABC, as expreſſed in laſt theorem, coſ. $\frac{1}{2}$ (A + B) : coſ. $\frac{1}{2}$ (A — B) :: tan. $\frac{1}{2}$ AB : tan. $\frac{1}{2}$ (BC + AC). Fig. 27.

SCHOLIUM.

Let one of the ſix parts of any ſpherical triangle be neglected ; let the one oppoſite to it, or its ſupplement, if an angle, be called the *middle part*, the two next to it the *adjacent parts*, and the remaining two the *oppoſite parts*. Then the four preceding propoſitions, which are called *Napier's Analogies*, becauſe firſt invented by him, may be included in one, as follows.

In any ſpherical triangle, the ſine or coſine of half the ſum of the adjacent parts, is to the ſine or coſine of half their difference, as the tangent of half the middle part to the tangent of half the difference or half the ſum of the oppoſite parts, that is,

Sin. $\frac{1}{2}$ (A + a) : ſin. $\frac{1}{2}$ (A — a) :: tan. $\frac{1}{2}$ M : tan. $\frac{1}{2}$ (O — o).
Coſ. $\frac{1}{2}$ (A + a) : coſ. $\frac{1}{2}$ (A — a) :: tan. $\frac{1}{2}$ M : tan. $\frac{1}{2}$ (O + o).

When A, a and M are given, by the firſt proportion, $\frac{1}{2}$ (O — o) is found, and by the ſecond $\frac{1}{2}$ (O + o) ; thence O and o may be had immediately by the problem following Theor. IV. PLANE TRIGONOMETRY.

The Caſes of Right-angled Spherical Triangles.

In a right-angled triangle, let c denote the ſide oppoſite the right angle, a, b the ſides containing it, and A, B the oppoſite angles, A being oppoſite to a, and B to b. Then, combining theſe quantities two by two, there will be found to be ſix diſtinct combinations, or caſes. Fig. 28.

CASE 1. When c, A, the hypothenuſe and one of the angles are given ; to find a, b, B.
a is found by Theor. XII. ; b by Theor. XIII. Cor. 2. and B by Theor. XIII. Cor. 1.

CASE 2. Given a, B, a ſide and its adjacent angle. Sought, A, b, c.
A is found by Theor. XII. Cor. 2. ; b by Theor. XIII. ; c by Theor. XIII. Cor. 2.

CASE 3. Given a, A, a ſide and its oppoſite angle ; to find b, B, c.
b is found by Theor. XIII. ; B by Theor. XII. ; Cor. 2. c by Theor. XII.

CASE 4. Given c, a, the hypothenuſe, and one of the ſides ; to find A, b, B.
A is found by Theor. XII. ; b by Theor. XII. Cor. 1. ; B by Theor. XIII. Cor. 2.

CASE 5. Given a, b, the two ſides. Sought A, B, c.

A is found by Theor. XIII.; B by the ſame; c by Theor. XII. Cor. 1.

CASE 6. Given A, B, the two angles. Sought a, b, c.

a and b are found by Theor. XII. Cor.; $2c$ by Theor. XIII. Cor. 1.

THE caſes may be all reſolved alſo by *Napier's Rules*, obſerving to make each of the things given the middle part; then two of the required parts will be found, and the remaining part is found by making it the middle part.

By Theor. II. and Cor. 1. each of the unknown parts is, in every caſe except the third, limited to one value.

The Caſes of Oblique-angled Spherical Triangles.

In any ſpherical triangle let the ſides be denoted by a, b, c, and the oppoſite angles by A, B, C reſpectively.

Let p, q denote the ſegments into which a ſide is divided by a perpendicular from the oppoſite angle, and P, Q the parts into which it divides the angle. Combining the ſix quantities a, b, c, A, B, C, three by three, there are found ſix diſtinct combinations or caſes.

CASE 1. Given a, A, b, two ſides and an angle oppoſite to one of them. Sought c, B, C.

B is found by Theor. XIV.; c by either Theor. XIX.; or Theor. XX.; C by Theor. XVII. or Theor. XVIII.

CASE 2. Given A, a, B, two angles and a ſide oppoſite to one of them. Sought b, c, C.

b is found by Theor. XIV.; c and C as in Caſe 1.

CASE 3. Given a, C, b, two ſides and the included angle. Sought A, B, c.

Find $\frac{1}{2}(A—B)$ by Theor. XVII. and $\frac{1}{2}(A+B)$ by Theor. XVIII. and thence A and B by the rule SECT. II. for finding each of two quantities whoſe ſum and difference are given. All the angles being known, alſo two ſides, c is found by Theor. XIV.

CASE 4. Given A, c, B, two angles and a ſide between them. Sought a, C, b.

Find $\frac{1}{2}(a—b)$ by Theor. XIX. and $\frac{1}{2}(a+b)$ by Theor. XX. and thence a, b. All the ſides and two angles being now known, C is found by Theor. XIV.

CASE 5. Given a, b, c, the three ſides. Sought A, B, C.

Draw a perpendicular from any one of the angles, dividing the oppoſite ſide into the ſegments p, q. Find $\frac{1}{2}(p—q)$ by Theor. XV. and then, from $\frac{1}{2}(p+q)$ and $\frac{1}{2}(p—q)$, find p, q. The triangle being now reſolved into two right-angled triangles, the angles may be found by Caſe 4. of right-angled triangles.

CASE 6. Given A, B, C, the three angles. Sought a, b, c.

Draw a perpendicular, dividing any one of the angles into the parts P, Q. Find $\frac{1}{2}$(P—Q) by Theor. XVI. and then P, Q. The triangle being now reſolved into two right-angled triangles, the ſides may be found by Caſe 6. of right-angled triangles.

BY Theor. X. XI. and Cor. each of the unknown parts is limited to one value in all the caſes, except in ſome of the ſubcaſes of the firſt and ſecond.

As every oblique-angled triangle may be reſolved into two right-angles, all theſe caſes may be reſolved by means of *Napier's Rule*, and the 15th propoſition only. And the caſes may be reduced to three, by uſing the ſupplemental triangle.

TRIHILATÆ, from *tres*, "three," and *hilum*, "an external mark on the ſeed;" the name of the 23d claſs in Linnæus's Fragments of a Natural Method;" conſiſting of plants with three ſeeds, which are marked with an external cicatrix or ſcar, where they are faſtened within the fruit. See BOTANY.

TRIM, implies in general the ſtate or diſpoſition by which a ſhip is beſt calculated for the ſeveral purpoſes of navigation.

Thus the trim of the hold denotes the moſt convenient and proper arrangement of the various materials contained therein relatively to the ſhip's motion or ſtability at ſea. The trim of the maſts and ſails is alſo their moſt appoſite ſituation with regard to the conſtruction of the ſhip and the effort of the wind upon her ſails. See SEAMANSHIP.

TRINGA, SANDPIPER; a genus of birds belonging to the order of grallæ. See ORNITHOLOGY *Index*.

TRINIDAD, an iſland in the gulf of Mexico, ſeparated from New Andaluſia, in Terra Firma, by a ſtrait about three miles over. The ſoil is fruitful, producing ſugar, cotton, Indian corn, fine tobacco, and fruits. It was taken by Sir Walter Raleigh in 1595, and by the French in 1676, who plundered the iſland and then left it. It is about 62 miles in length, and 45 in breadth; and was diſcovered by Chriſtopher Columbus in 1498. It is now in the poſſeſſion of Britain. What was called a bituminous lake in this iſland, appears, from the experiments of Mr Hatchet, to be a porous ſtone from which the mineral pitch exudes.

TRINITARIANS, thoſe who believe in the Trinity; thoſe who do not believe therein being called *Antitrinitarians*.

Fig. 1.

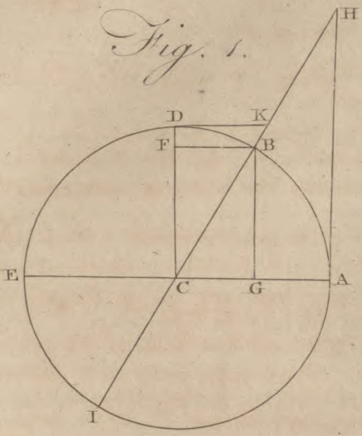


Fig. 2.

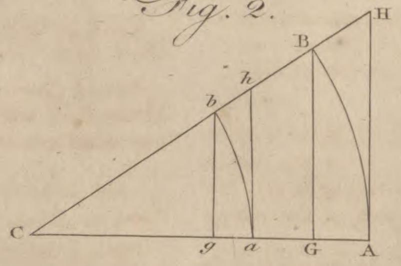


Fig. 3.

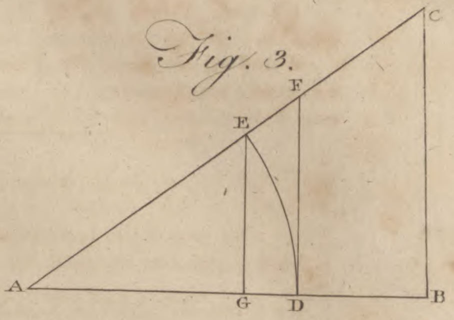
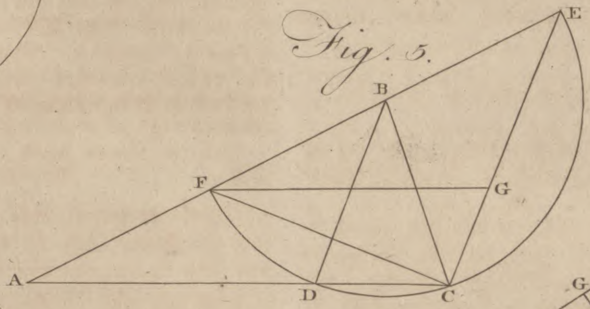


Fig. 5.



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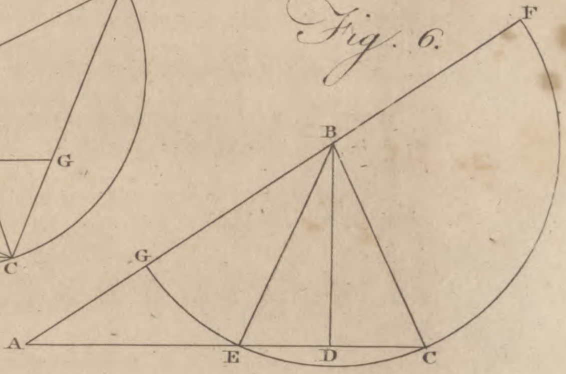

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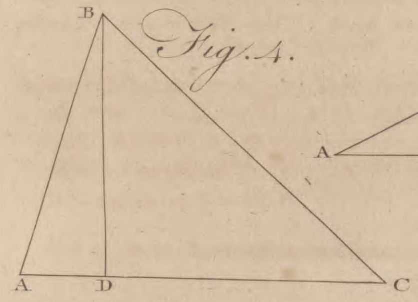


Fig. 8.

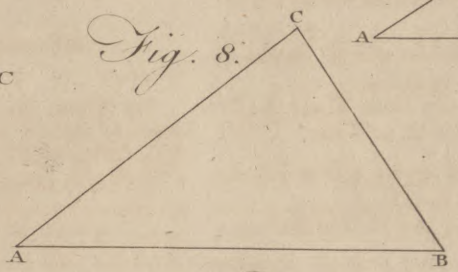


Fig. 9.

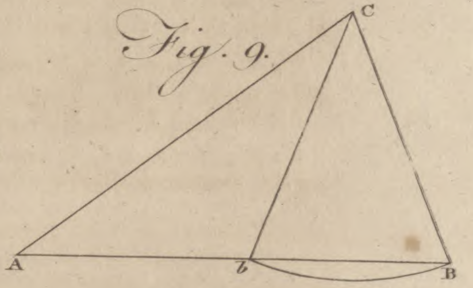


Fig. 7.

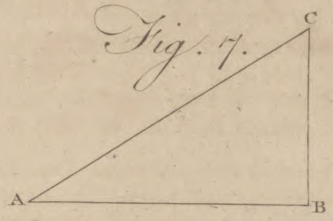


Fig. 12.

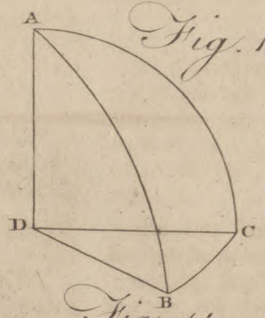


Fig. 10.

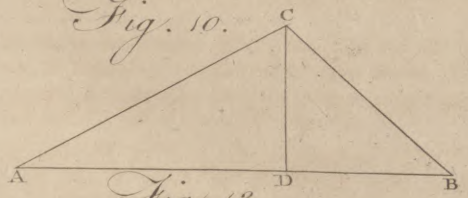


Fig. 13.

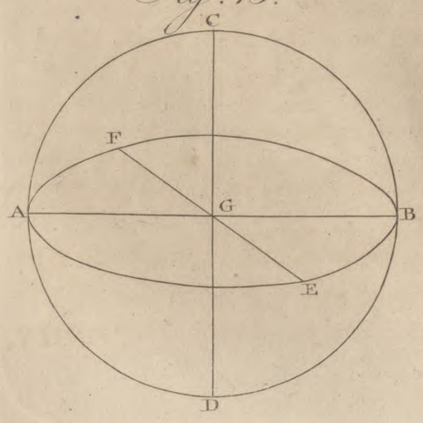


Fig. 14.

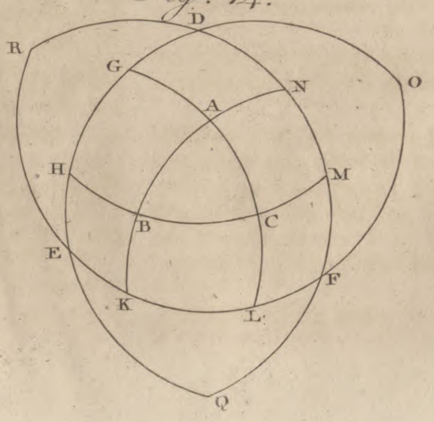
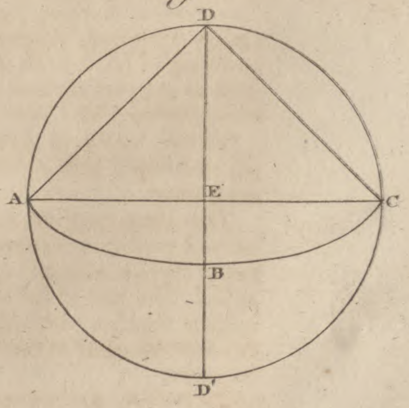


Fig. 11.



W. Train Sculpt.

Fig. 15.

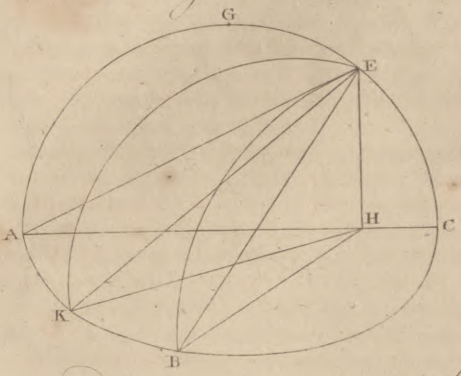
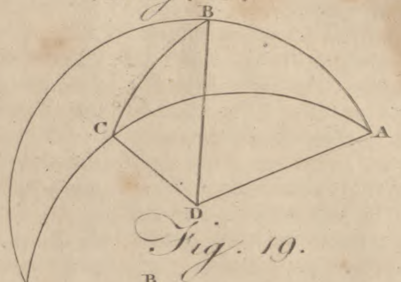


Fig. 16.



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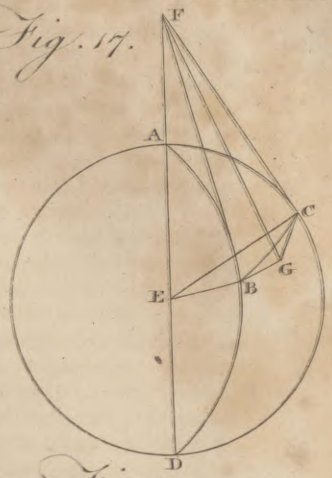

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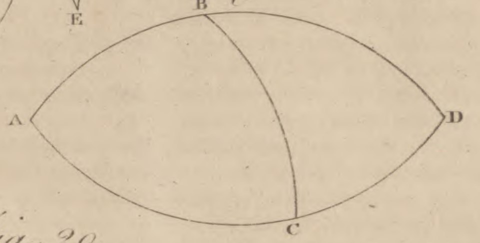

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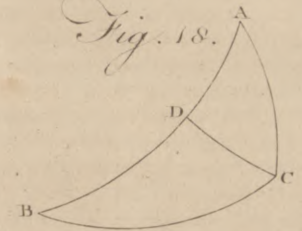


Fig. 21.

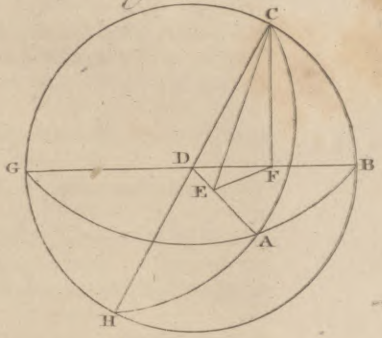


Fig. 20.

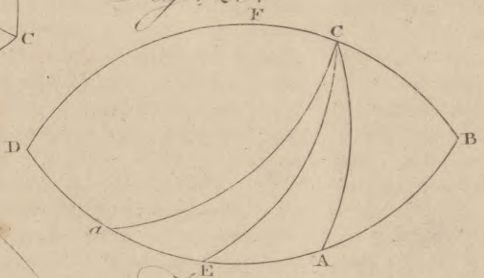
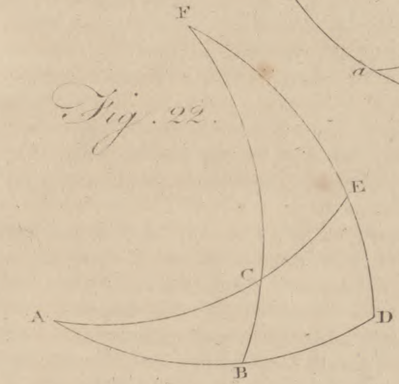


Fig. 22.



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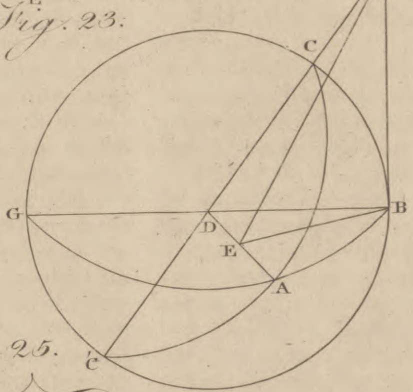


Fig. 24.

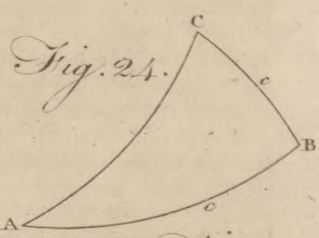


Fig. 27.

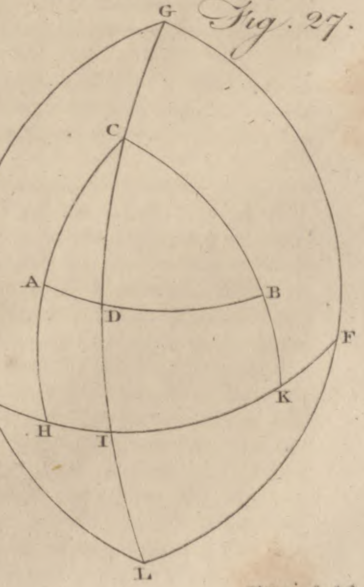


Fig. 25.

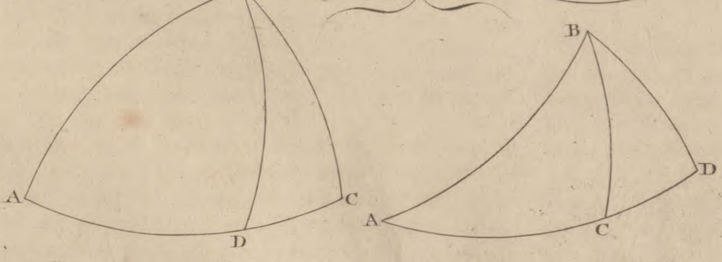


Fig. 26.

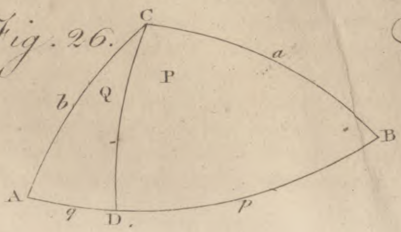
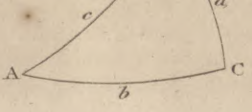


Fig. 28.



W. Prain Sculp.

TRINITY, in *Theology*, the ineffable myſtery of three perſons in one God; Father, Son, and Holy Spirit. See Theology.

Trinity-Houſe. See London, N° 49.

Trinity-Sunday, a feſtival obſerved on the Sunday next after Whitſunday, in honour of the holy Trinity. The obſervation of this feſtival was firſt enjoined in the council of Arles, anno 1260.

TRINOBANTES, in *Ancient Geography*, a people of Britain, ſuppoſed to have occupied Middleſex and Eſſex.

TRIO, in *Muſic*, a part of a concert wherein three perſons ſing; or, more properly, a muſical compoſition conſiſting of three parts.

TRIPHTHONG, in *Grammar*, an aſſemblage or concourſe of three vowels in one ſyllable; as *quæ*.

TRIPLE, in *Muſic*, is one of the ſpecies of meaſure or time. See Music.

TRIPOD, in antiquity, a famed ſacred ſeat or ſtool, ſupported by three feet, whereon the prieſts and ſibyls were placed to render oracles. It was on the tripod that the gods were ſaid to inſpire the Pythias with that divine fury and enthuſiaſm wherewith they were ſeized at the delivery of their predictions.

TRIPOLI, a country of Africa, in Barbary; bounded on the north by the Mediterranean ſea; on the ſouth, by the country of the Beriberies; on the weſt, by the kingdom of Tunis, Biledulgerid, and territory of the Gadamis; and on the eaſt, by Egypt. It is about 925 miles along the ſea coaſt; but the breadth is various. Some parts of it are pretty fruitful; but that towards Egypt is a ſandy deſert. It had the title of a *kingdom;* but is now a republic, governed by a dey. He is not abſolute; for a Turkiſh baſhaw reſides here, who receives his authority from the grand ſeignior, and has a power of controuling the dey, and levying taxes on the people. The dey is elected by the ſoldiers, who make no ſcruple of depoſing him when they pleaſe.

Tripoli, a conſiderable town of Africa, and capital of a republic of the ſame name in Barbary, and under protection of the grand ſeignior, with a caſtle and a fort. It is pretty large, and the inhabitants are noted pirates. It was taken by Charles V. who ſettled the knights of Malta there; but they were driven away by the Turks in 1551. It was formerly very flouriſhing; and has now ſome trade in ſtuffs, ſaffron, corn, oil, wool, dates, oſtrich feathers, and ſkins: but they make more of the Chriſtian ſlaves which they take at ſea; for they either ſet high ranſoms upon them, or make them perform all ſorts of work. It is ſeated on the coaſt of the Mediterranean, in a ſandy ſoil, and ſurrounded by a wall, ſtrengthened by other fortifications. E. Long. 13. 12. N. Lat. 32. 34.

Tripoli, called *Tripolis* of *Syria*, to diſtinguiſh it from Tripoli in *Barbary*, received its name from its being anciently formed of three cities at a ſmall diſtance from each other, one of which belonged to the Aradians, or ancient kingdom of Arad, the ſecond to the Sidonians, and the third to the Tyrians, perhaps as a common mart to thoſe maritime powers. The preſent town of Tripoli is built at the diſtance of a mile and a half from the other, upon the declivity of a hill facing the ſea, in 34° 20′ north latitude, and in 35° 50′ eaſt longitude from Greenwich. It is ſurrounded with walls, fortified with ſeven high ſtrong towers, and a caſtle, all of Gothic architecture; but the ſtreets are narrow, and the houſes low. The city contains about 8000 houſes, and near 60,000 inhabitants, conſiſting of Turks, Chriſtians, and Jews. The baſha, or pacha, who reſides in the caſtle, where there is a garriſon of 200 janizaries, governs the adjacent territory, in which there is plenty of fruit, and a great number of mulberry trees, which enable the inhabitants to carry on a ſilk manufacture, from which they draw conſiderable profit.

All the environs of Tripoli are laid out in orchards, where the nopal grows ſpontaneouſly, and the white mulberry is cultivated for the ſilk-worm; the pomegranate, orange, and lemon trees for their fruit, which is here very fine. The country, though delightful to the eye, is unhealthy; from July to September, epidemic fevers, like thoſe of Scanderoon and Cyprus, prevail, and are principally cauſed by the artificial inundations made for the purpoſe of watering the mulberry trees, to enable them to throw out their ſecond leaves, and from a want of free circulation of air, the city being open only to the weſtward.

Tripoli, a ſpecies of argillaceous earth, much uſed in the poliſhing of metals. See Mineralogy *Index*.

TRIPTOLEMUS, Laws of. See Myſteries, N° 74.

TRIQUETROUS, among botaniſts, denotes a fruit or leaf that has three flat ſides or faces.

TRIREMIS, in antiquity, a galley with three ranks of oars on a ſide.

TRISMEGISTUS, an epithet or ſurname given to one of the two Hermeſes. See Thoth.

TRISMUS, the Locked Jaw. See Medicine, N° 280.

TRISSYLLABLE, in *Grammar*, a word conſiſting of three ſyllables.

TRITICUM, Wheat; a genus of plants belonging to the claſs of triandria; and in the natural ſyſtem ranging under the 4th order, *Gramina*. See Botany and Agriculture *Index*.

TRITON, a ſea demigod, held by the ancients to be an officer or trumpeter of Neptune, attending on him, and carrying his orders from ſea to ſea.

TRITURATION, the act of reducing a ſolid body into a ſubtile powder; called alſo *pulveriſation* and *levigation*.

TRIUMPH, in Roman antiquity, a public and ſolemn honour conferred by the Romans on a victorious general by allowing him a magnificent entry into the city.

The greater triumph, called alſo *curulis*, or ſimply the *triumph*, was decreed by the ſenate to a general, upon the conquering of a province or gaining a ſignal victory. The day appointed for the ceremony being arrived, ſcaffolds were erected in the forum and circus, and all the other parts of the city where they could beſt behold the pomp: the ſenate went to meet the conqueror without the gate called *Capena* or *Triumphalis*, and marched back in order to the Capitol; the ways being cleared and cleanſed by a number of officers and tipſtaffs, who drove away ſuch as thronged the paſſage or ſtraggled up and down. The general was clad in a rich purple robe, interwoven with figures of gold, ſetting forth his great exploits; his buſkins were beſet with pearl; and he wore a crown, which at firſt was only laurel, but afterwards gold; in one hand he bore a branch of laurel, and in the other a truncheon. He was carried in a magnificent chariot, adorned with ivory and plates of gold, drawn uſually by two white horſes; though ſometimes by other animals, as that of Pompey, when he triumphed over Africa, by elephants; that of Mark Antony by lions; that of Heliogabalus by tygers; that of Aurelian by deer, &c. His children were at his feet, and ſometimes on the chariot-horſes. The proceſſion was led by the muſicians, who played triumphal pieces in praiſe of the general: theſe were followed by young men, who led the victims to the ſacrifice, with their horns gilded, and their heads adorned with ribbands and garlands; next came the carts and waggons, loaded with all the ſpoils taken from the enemy, with their horſes, chariots, &c.; theſe were followed by the kings, princes, and generals, who had been taken captives, loaded with chains: after theſe appeared the triumphal chariot, before which, as it paſſed, they all along ſtrewed flowers, and the people with loud acclamations called out, *Io triumphe!* The chariot was followed by the ſenate, clad in white robes; and the ſenate by ſuch citizens as had been ſet at liberty or ranſomed; and the proceſſion was cloſed by the prieſts and their officers and utenſils, with a white ox led along for the chief victim. In this order they proceeded through the triumphal gate, along the Via Sacra, to the Capitol, where the victims were ſlain. In the mean time all the temples were open, and all the altars loaded with offerings and incenſe; games and combats were celebrated in the public places, and rejoicings appeared everywhere.

TRIUMVIR, one of three perſons who govern abſolutely, and with equal authority, in a ſtate. It is chiefly applied to the Roman government: Cæſar, Pompey, and Craſſus, were the firſt triumvirs who divided the government among them. There were alſo other officers ſo called; as the triumviri or treſviri capitales, who were the keepers of the public gaol: they had the office of puniſhing malefactors; for which purpoſe they kept eight lictors under them.

TROAS, a country of Phrygia in Aſia Minor, of which Troy was the capital. When Troas is taken for the whole kingdom of Priam, it may be ſaid to contain Myſia and Phrygia Minor; but if only applied to that part of the country where Troy was ſituated, its extent is confined within very narrow limits. Troas was anciently called Dardania. See TROJA.

TROCHÆUS, in proſody, a foot conſiſting of a long and ſhort ſyllable.

TROCHANTER, in *Anatomy*. See there, N° 58.

TROCHE, in *Pharmacy*, a ſort of medicine made of glutinous ſubſtances into little cakes, and afterwards exſiccated. See MATERIA MEDICA *Index*.

TROCHILUS, HUMMING BIRD, a genus of birds belonging to the order of picæ. See ORNITHOLOGY *Index*.

TROGLODYTES, in the *Ancient Geography*, a people of Ethiopia, ſaid to have lived in caves under ground. Pomponius Mela gives a ſtrange account of the Troglodytes: he ſays, they did not ſo properly ſpeak as ſhriek; and that they lived on ſerpents.

TROGUS POMPEIUS, a Latin univerſal hiſtorian to the time of Auguſtus Cæſar, of whom we have only an abridgement by Juſtin, flouriſhed about 41 B. C.

TROJA, the capital city of Troas, or, according to others, a country of which Ilium was the capital. It was built on a ſmall eminence near Mount Ida, and the promontory of Sigæum, at the diſtance of about four miles from the ſea-ſhore. Dardanus the firſt king of the country built it, and called it *Dardania*, and from Tros one of his ſucceſſors it was called *Troja*, and from Ilus *Ilion*. This city has been celebrated by the poems of Homer and Virgil; and of all the wars which have been carried on among the ancients, that of Troy is the moſt famous.

A deſcription of the plain of Troy has been publiſhed in French in the 3d volume of the Philoſophical Tranſactions of the Royal Society of Edinburgh, written by M. Chevalier. The city of Troy, according to him, ſtood on the preſent ſite of the modern village of Bounarbachi, diſtant four leagues from the ſea, and which is the reſidence of an aga, ruling with abſolute ſway the inhabitants of the Trojan plain and the inferior agas, to whom they are immediately ſubject. Bounarbachi is ſituated on the ſide of an eminence, expoſed to every wind, at the termination of a ſpacious plain, the ſoil of which is rich and of a blackiſh colour. Cloſe to the village is to be ſeen a marſh covered with tall reeds; and the ſituation is impregnable on all ſides except at Erin (Homer's ερινεος), the *hill of wild fig trees*, which extended between the Scæan gate and the ſources of the Scamander. Theſe circumſtances, agreeing with Homer's deſcriptions, ſtrongly ſupport M. Chevalier's opinion concerning the ſituation of Troy. A very intereſting part of this work is the account of conical mounds or barrows, ſeveral of them 100 feet in diameter at the baſe; and which the author maintains to be the identical tombs raiſed over the aſhes of the heroes of the Trojan war; ſome of them he deems more ancient. He deſcribes particularly the tombs of Eſyetes, Ilus, Ajax, Hector, Achilles, Patroclus, and Antilochus.

This diſſertation, which runs to the length of 92 quarto pages, is replete with erudition and ingenious reaſoning, and is illuſtrated and embelliſhed by maps of the plain of Troy and ſeveral tables of inſcriptions. It has been tranſlated with much accuracy and care by Mr Dalzel profeſſor of Greek in the Univerſity of Edinburgh, and accompanied with large notes and illuſtrations.

TROLLIUS, GLOBE-FLOWER, or *Lucken Gowan*, a genus of plants belonging to the claſs of polyandria; and in the natural ſyſtem ranging under the 26th order, *Multiſiliquæ*. See BOTANY *Index*.

TROMP, MARTIN HAPPERTZ VAN, a celebrated Dutch admiral, was born at the Baille, in Holland. He raiſed himſelf by his merit, after having diſtinguiſhed himſelf on many occaſions, eſpecially at the famous engagement near Gibraltar in 1607. He paſſed for one of the greateſt ſeamen that had till that time appeared in the world; and was declared admiral of Holland, even by the advice of the prince of Orange. He in that character defeated a large Spaniſh fleet in 1630, and gained 32 other victories at ſea; but was killed when under deck, in an engagement with the Engliſh in 1653. The ſtates-general cauſed medals to be ſtruck to his honour, and lamented him as one of the greateſt heroes of their republic. Van Tromp, in the midſt of the greateſt glory, conſtantly diſcovered a remarkable modeſty; for he never aſſumed a higher character

racter than that of a burgher, and that of being the father of the ſailors.

TRONAGE, an ancient cuſtomary duty or toll, for weighing of wool. According to Fleta, *trona* is a beam to weigh with, mentioned in the ſtat. Weſtm. 2. cap. 25. And tronage was uſed for the weighing wool in a ſtaple or public mart, by a common trona or beam; which, for the tronage of wool in London, was fixed at Leaden-Hall. The mayor and commonalty of London are ordained keepers of the beams and weights for weighing merchants commodities, with power to aſſign clerks and porters, &c. of the great beam and balance; which weighing of goods and wares is called *tronage;* and no ſtranger ſhall buy any goods in London before they are weighed at the king's beam, on pain of forfeiture.

TRONE-WEIGHT, the moſt ancient of the different weights uſed in Scotland; and, though now forbidden by ſeveral ſtatutes, is ſtill uſed by many for home commodities, and that in a very irregular manner; for the pound varies in different places, and for different purpoſes, from 20 to 24 Dutch ounces. The common allowance is 21½ ounces for wool, 20½ for butter and cheeſe, 20 for tallow, lint, hemp, and hay. It is divided into 16 of its own ounces, and 16 pounds make a ſtone.

TROOP, a ſmall body of horſe or dragoons, about 50 or 60, ſometimes more, ſometimes leſs, commanded by a captain, lieutenant, cornet, quarter-maſter, and three corporals, who are the loweſt officers of a troop.

TROPE. See ORATORY, N° 52—66.

TROPHONIUS's CAVE, or *Oracle*, in *Ancient Geography*, a cave near Lebadia in Bœotia, between Helicon and Chæronea (Strabo): ſo called from Trophonius, an enthuſiaſtic diviner; who, deſcending into this cave, pretended to give anſwers and pronounce oracles; and was hence called *Jupiter Trophonius*. Such as went down to this cave never after ſmiled; hence the proverbial ſaying of a man who has loſt his mirth, That he is come out of Trophonius's cave. Though Pauſanias, who writes from experience, contradicts this; affirming that perſons came out of the cave affected indeed with a ſtupor, but that they ſoon after recovered themſelves. See ORACLE.

TROPHY (*Tropæum*), among the ancients, a monument of victory.

TROPIC-BIRD. See PHAETON, ORNITHOLOGY *Index*.

TROPICS. See GEOGRAPHY.

TROUBADOURS, poets that flouriſhed in Provence during the 12th century.

They wrote poems on love and gallantry; on the illuſtrious characters and remarkable events of the times; ſatires which were chiefly directed againſt the clergy and monks; and a few didactic pieces. The troubadours were great favourites in different courts, diffuſed a taſte for their language and for poetry over Europe, which was about that time ſunk in ignorance and rudeneſs; they diſappeared in the 14th century. A hiſtory of the troubadours in 3 vols 12mo, was begun by M. de Sainte Palaie, and finiſhed by the abbé Millot. See MUSIC.

TROUGH, GALVANIC. See GALVANISM. For later diſcoveries in galvanic electricity, ſee ZINC.

TROVER, in *Law*, an action that a man hath againſt one that, having found any of his goods, refuſeth to deliver them upon demand.

TROUT. See SALMO, ICHTHYOLOGY *Index*.

TROY. See TROJA.

TROY-Weight, one of the moſt ancient of the different kinds uſed in Britain. The ounce of this weight was brought from Grand Cairo in Egypt, about the time of the cruſades, into Europe, and firſt adopted in *Troyes*, a city of Champagne; whence the name.

The pound *Engliſh* Troy contains 12 ounces, or 5760 grains. It was formerly uſed for every purpoſe; and is ſtill retained for weighing gold, ſilver, and jewels; for compounding medicines; for experiments in natural philoſophy; and for comparing different weights with each other.

Scots TROY-Weight was eſtabliſhed by James VI. in the year 1618, who enacted, that only one weight ſhould be uſed in Scotland, viz. the French Troy ſtone of 16 pounds, and 16 ounces in the pound. The pound contains 7600 grains, and is equal to 17 oz. 6 dr. avoirdupois. The cwt. or 112 lb. avoirdupois, contains only 103 lb. 2½ oz. of this weight, though generally reckoned equal to 104 lb. This weight is nearly, if not exactly, the ſame as that of Paris and Amſterdam; and is generally known by the name of *Dutch weight*. Though prohibited by the articles of union, it is ſtill uſed in weighing iron, hemp, flax, moſt Dutch and Baltic goods, meal, butcher-meat, unwrought pewter and lead, and ſome other articles.

TRUE-LOVE. See PARIS, BOTANY *Index*.

TRUFFLES. See LYCOPERDON, BOTANY *Index*.

TRUMPET, a muſical inſtrument, the moſt noble of all portable ones of the wind kind; uſed chiefly in war, among the cavalry to direct them in the ſervice. Each troop of cavalry has one. The cords of the trumpets are of crimſon, mixed with the colours of the facings of the regiments.

As to the invention of the trumpet, ſome Greek hiſtorians aſcribe it to the Tyrrhenians; but others, with greater probability, to the Egyptians; from whom it might have been tranſmitted to the Iſraelites. The trumpet was not in uſe among the Greeks at the time of the Trojan war; though it was in common uſe in the time of Homer. According to Potter (*Arch. Græc.* vol. ii. cap. 9.), before the invention of trumpets, the firſt ſignals of battle in primitive wars were lighted torches; to theſe ſucceeded ſhells of fiſhes, which were ſounded like trumpets. And when the trumpet became common in military uſe, it may well be imagined to have ſerved at firſt only as a rough and noiſy ſignal of battle, like that at preſent in Abyſſinia and New Zealand, and perhaps with only one ſound. But, even when more notes were produced from it, ſo noiſy an inſtrument muſt have been an unfit accompaniment for the voice and poetry; ſo that it is probable the trumpet was the firſt ſolo inſtrument in uſe among the ancients.

TRUMPET, Articulate, comprehends both the *ſpeaking* and the *hearing* trumpet, is by much the moſt valuable inſtrument, and has, in one of its forms, been uſed by people among whom we ſhould hardly have expected to find ſuch improvements.

That the *ſpeaking trumpet*, of which the object is to increaſe the force of articulate ſounds, ſhould have been known to the ancient Greeks, can excite no wonder;

and therefore we eaſily admit the accounts which we read of the horn or trumpet, with which Alexander addreſſed his army, as well as of the whiſpering caverns of the Syracuſan tyrant. But that the natives of Peru were acquainted with this inſtrument, will probably ſurpriſe many of our readers. The fact, however, ſeems incontrovertible.

In the Hiſtory of the Order of Jeſuits, publiſhed at Naples in 1601 by Beritaria, it is ſaid, that in the year 1595 a ſmall convent of that order in Peru, ſituated in a remote corner, was in danger of immediate deſtruction by famine. One evening the ſuperior Father Samaniac implored the help of the cacique; next morning, on opening the gate of the monaſtery, he found it ſurrounded by a number of women, each of whom carried a ſmall baſket of proviſions. He returned thanks to heaven for having miraculouſly interpoſed, by inſpiring the good people with pity for the diſtreſs of his friars. But when he expreſſed to them his wonder how they came all to be moved as if by mutual agreement with theſe benevolent ſentiments, they told him it was no ſuch thing; that they looked upon him and his countrymen as a pack of infernal magicians, who by their ſorceries had enſlaved the country, and had bewitched their good cacique, who hitherto had treated them with kindneſs and attention, as became a true worſhipper of the ſun; but that the preceding evening at ſunſet he had ordered the inhabitants of ſuch and ſuch villages, about ſix miles off, to come that morning with proviſions to this neſt of wizzards.

The ſuperior aſked them in what manner the governor had warned ſo many of them in ſo ſhort a time, at ſuch a diſtance from his own reſidence? They told him that it was by the trumpet; and that every perſon heard at their own door the diſtinct terms of the order. The father had heard nothing; but they told him that none heard the trumpet but the inhabitants of the villages to which it was directed. This is a piece of very curious information; but, after allowing a good deal to the exaggeration of the reverend Jeſuits, it cannot, we think, be doubted but that the Peruvians actually poſſeſſed this ſtentorophonic art. For we may obſerve that the effect deſcribed in this narration reſembles what *we now know* to be the effect of ſpeaking trumpets, while it is unlike what the inventor of ſuch a tale would naturally and ignorantly ſay. Till ſpeaking trumpets were really known, we ſhould expect the ſound to be equally diffuſed on all ſides, which is not the caſe; for it is much ſtronger in the line of the trumpet than in any direction very oblique to it.

About the middle of the 17th century, Athanaſius Kircher turned his attention to the philoſophy of ſound, and in different works threw out many uſeful and ſcientific hints on the conſtruction of ſpeaking trumpets (ſee ACOUSTICS and KIRCHER); but his mathematical illuſtrations were ſo vague, and his own character of inattention and credulity ſo notorious, that for ſome time theſe works did not attract the notice to which they were well entitled.

About the year 1670, Sir Samuel Morland, a gentleman of great ingenuity, ſcience, and order, took up the ſubject, and propoſed as a queſtion to the Royal Society of London, What is the beſt form for a ſpeaking trumpet? which he called a ſtentorophonic horn. He accompanied his demand with an account of his own notions on the ſubject (which he acknowledged to be very vague and conjectural), and an exhibition of ſome inſtruments conſtructed according to his views. They were in general very large conical tubes, ſuddenly ſpreading at the very mouth to a greater width. Their effect was really wonderful. They were tried in St James's park; and his Majeſty K. Charles II. ſpeaking in his ordinary colloquial pitch of voice through a trumpet only $5\frac{1}{2}$ feet long, was clearly and moſt diſtinctly heard at the diſtance of a thouſand yards. Another perſon, ſelected we ſuppoſe for the loudneſs and diſtinctneſs of his voice, was perfectly underſtood at the diſtance of four miles and a half. The fame of this ſoon ſpread; Sir Samuel Morland's principles were refined, conſidering the novelty of the thing, and differ conſiderably from Father Kircher's. The aërial undulations, (for he ſpeaks very accurately concerning the nature of ſound) endeavour to diffuſe themſelves in ſpheres, but are ſtopped by the tube, and therefore reundulate towards the axis like waves from a bank, and, meeting in the axis, they form a ſtrong undulation a little farther advanced along the tube, which again ſpreads, is again reflected, and ſo on, till it arrives at the mouth of the tube greatly magnified, and then it is diffuſed through the open air in the ſame manner, as if all proceeded from a very ſonorous point in the centre of the wide end of the trumpet. The author diſtinguiſhes with great judgement between the prodigious reinforcement of ſound in a ſpeaking trumpet and that in the muſical trumpet, bugle-horn, conch-ſhell, &c.; and ſhows that the difference conſiſts only in the violence of the firſt ſonorous agitation, which can be produced by us only on a very ſmall extent of ſurface. The mouth-piece diameter, therefore, of the muſical trumpet muſt be very ſmall, and the force of blaſt very conſiderable. Thus one ſtrong but ſimple undulation will be excited, which muſt be ſubjected to the modifications of harmony, and will be augmented by uſing a conical tube (A). But a ſpeaking trumpet muſt make no change on the nature of the firſt undulations; and each point of the mouth-piece muſt be equally conſidered as the centre of ſonorous undulations, all of which muſt be reinforced in the ſame degree, otherwiſe all diſtinctneſs of articulation will be loſt. The mouth-piece muſt therefore take in the whole of the mouth of the ſpeaker.

When Sir Samuel Morland's trumpet came to be generally known on the continent, it was ſoon diſcovered that the ſpeaker could be heard at a great diſtance only in the line of the trumpet; and this circumſtance was by a a Mr Caſſegrain (*Journ. des Sçavans*, 1672, p. 131.) attributed to a defect in the principle of its conſtruction, which he ſaid was not according to the laws of ſonorous undulations. He propoſed a conoid formed by the revolution of a hyperbola round its aſſymptote as the beſt form. A Mr Haſe of Wirtemberg, on the other hand, propoſed a parabolic conoid, having the mouth of the ſpeaker

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(A) Accordingly the ſound of the bugle horn, of the muſical trumpet, or the French horn, is prodigiouſly loud, when we conſider the ſmall paſſage through which a moderate blaſt is ſent by the trumpeter.

ſpeaker placed in the focus. In this conſtruction he plainly went on the principle of a reflection ſimilar to that of the rays of light; but this is by no means the caſe. The effect of the parabola will be to give one reflection, and in this all the circular undulations will be converted into plane waves, which are at right angles to the axis of the trumpet. But nothing hinders their ſubſequent diffuſion; for it does not appear that the ſound will be enforced, becauſe the agitation of the particles on each wave is not augmented.

The ſubject is exceedingly difficult. We do not fully comprehend on what circumſtance the affection or agitation of our organ, or ſimply of the membrana tympani, depends. A more violent agitation of the ſame air, that is, a wider oſcillation of its particles, cannot fail to increaſe the impulſe on this membrane. The point therefore is to find what concourſe of feeble undulations will produce or be equivalent to a great one. The reaſonings of all theſe reſtorers of the ſpeaking trumpet are almoſt equally ſpecious, and each point out ſome phenomenon which ſhould characteriſe the principle of conſtruction, and thus enable us to ſay which is moſt agreeable to the procedure of nature. Yet there is hardly any difference in the performance of trumpets of equal dimenſions made after theſe different methods.

The propagation of light and of elaſtic undulations ſeem to require very different methods of management. Yet the ordinary phenomena of echoes are perfectly explicable by the acknowledged laws either of optics or acouſtics; ſtill however there are ſome phenomena of ſound which are very unlike the genuine reſults of elaſtic undulations. If ſounds are propagated ſpherically, then what comes into a room by a ſmall hole ſhould diffuſe itſelf from that hole as round a centre, and it ſhould be heard equally well at twelve feet diſtance from the hole in every direction. Yet it is very ſenſibly louder when the hearer is in the ſtraight line drawn from the ſonorous body through the hole. A perſon can judge of the direction of the ſounding body with tolerable exactneſs. Cannon diſcharged from the different ſides of a ſhip are very eaſily diſtinguiſhed, which ſhould not be the caſe by the Newtonian theory; for in this the two pulſes on the ear ſhould have no ſenſible difference.

The moſt important fact for our purpoſe is this: An echo from a ſmall plane ſurface in the midſt of an open field is not heard, unleſs we ſtand in ſuch a ſituation that the angle of reflected ſound may be equal to that of incidence. But by the uſual theory of undulations, this ſmall ſurface ſhould become the centre of a new undulation, which ſhould ſpread in all directions. If we make an analogous experiment on watery undulations, by placing a ſmall flat ſurface ſo as to project a little above the water, and then drop in a ſmall pebble at a diſtance, ſo as to raiſe one circular wave, we ſhall obſerve, that when this wave arrives at the projecting plane, it is diſturbed by it, and this diſturbance ſpreads from it on all ſides. It is indeed ſenſibly ſtronger in that line which is drawn from it at equal angles with the line drawn to the place where the pebble was dropped. But in the caſe of ſound, it is a fact, that if we go to a very ſmall diſtance on either ſide of the line of reflection, we ſhall hear nothing.

Here then is a fact, that whatever may be the nature of the elaſtic undulations, ſounds are reflected from a ſmall plane in the ſame manner as light. We may avail ourſelves of this fact as a mean for enforcing ſound, though we cannot explain it in a ſatisfactory manner. We ſhould expect from it an effect ſimilar to the hearing of the original ſound along with another original ſound coming from the place from which this reflected ſound diverges. If therefore the reflected ſound or echo arrives at the ear in the ſame inſtant with the original ſound, the effect will be doubled; or at leaſt it will be the ſame with two ſimultaneous original ſounds. Now we know that this is in ſome ſenſe equivalent to a ſtronger ſound. For it is a fact, that a number of voices uttering the ſame or equal ſounds are heard at a much greater diſtance than a ſingle voice. We cannot perhaps explain how this happens by mechanical laws, nor aſſign the exact proportion in which 10 voices exceed the effect of one voice; nor the proportion of the diſtances at which they ſeem equally loud. We may therefore, for the preſent, ſuppoſe that two equal voices at the ſame diſtance are twice as loud, three voices three times as loud, &c. Therefore if, by means of a ſpeaking trumpet, we can make 10 equal echoes arrive at the ear at the ſame moment, we may ſuppoſe its effect to be to increaſe the audibility 10 times; and we may expreſs this ſhortly, by calling the ſound 10 times louder or more intenſe.

But we cannot do this preciſely. We cannot by any contrivance make the ſound of a momentary ſnap, and thoſe of its echoes, arrive at the ear in the ſame moment, becauſe they come from different diſtances. But if the original noiſe be a continued ſound, a man's voice, for example, uttering a continued uniform tone, the firſt echo may reach the ear at the ſame moment with the ſecond vibration of the larynx; the ſecond echo along with the third vibration, and ſo on. It is evident, that this will produce the ſame effect. The only difference will be, that the articulations of the voice will be made indiſtinct, if the echoes come from very different diſtances. Thus if a man pronounce the ſyllable *taw*, and the 10 ſucceſſive echoes are made from places which are 10 feet farther off, the 10th part of a ſecond (nearly) will intervene between hearing the firſt and the laſt. This will give it the ſound of the ſyllable *thaw*, or perhaps *raw*, becauſe *r* is the repetition of *t*. Something like this occurs when, ſtanding at one end of a long line of ſoldiers, we hear the muſkets of the whole line diſcharged in one inſtant. It ſeems to us the ſound of a running fire.

The aim therefore in the conſtruction of a ſpeaking trumpet may be, to cauſe as many echoes as poſſible to reach a diſtant ear without any perceptible interval of time. This will give diſtinctneſs, and ſomething equivalent to loudneſs. *Pure* loudneſs ariſes from the violence of the ſingle aerial undulation. To increaſe this may be the aim in the conſtruction of a trumpet; but we are not ſufficiently acquainted with the mechaniſm of theſe undulations to bring this about with certainty and preciſion; whereas we can procure this accumulation of echoes without much trouble, ſince we know that echoes are, *in fact*, reflected like light. We can form a trumpet ſo that many of theſe lines of reflected ſound ſhall paſs through the place of the hearer. We are indebted to Mr Lambert of Berlin for this ſimple and popular view of the ſubject; and ſhall here give an abſtract of his moſt ingenious Diſſertation on Acouſtic Inſtruments, publiſhed in the Berlin Memoirs for 1763.

Sound naturally ſpreads in all directions; but we know that echoes or reflected ſounds proceed almoſt ſtrictly in certain limited directions. If therefore we contrive a trumpet in ſuch a way that the lines of echo ſhall be confined within a certain ſpace, it is reaſonable to ſuppoſe that the ſound will become more audible in proportion as this diffuſion is prevented. Therefore if we can oblige a ſound which, in the open air, would have diffuſed itſelf over a hemiſphere, to keep within a cone of 120 degrees, we ſhould expect it to be twice as audible within this cone. This will be accompliſhed, by making the reflections ſuch that the lines of reflected ſound ſhall be confined within this cone. *N. B.* We here ſuppoſe that nothing is loſt in the reflection. Let us examine the effect of a cylindrical trumpet.

Plate DXXXIX. Fig. 1. Let the trumpet be a cylinder ABED, (fig. 1.), and let C be a ſounding point in the axis. It is evident that all the ſound in the cone BCE will go forward without any reflection. Let CM be any other line of ſound, which we may, for brevity's ſake, call a *ſonorous* or *phonic line.* Being reflected in the points M, N, O, P, it is evident that it will at laſt eſcape from the trumpet in a direction PQ, equally diverging from the axis with the line CM. The ſame muſt be true of every other ſonorous line. Therefore the echoes will all diverge from the mouth of the trumpet in the ſame manner as they would have proceeded from C without any trumpet. Even ſuppoſing, therefore, that the echoes are as ſtrong as the original ſound, no advantage is gained by ſuch a trumpet, but that of bringing the ſound forward from C to *c*. This is quite trifling when the hearer is at a diſtance. Yet we ſee that ſounds may be heard at a very great diſtance, at the end of long, narrow, cylindrical, or priſmatical galleries. It is known that a voice may be diſtinctly heard at the diſtance of ſeveral hundred feet in the Roman aqueducts, whoſe ſides are perfectly ſtraight and ſmooth, being plaſtered with ſtucco. The ſmooth ſurface of the ſtill water greatly contributes to this effect. Cylindrical or priſmatical trumpets muſt therefore be rejected.

Fig. 2. Let the trumpet be a cone BCA (fig. 2.), of which CN is the axis, DK a line perpendicular to the axis, and DFHI the path of a reflected ſound in the plane of the axis. The laſt angle of reflection IHA is equal to the laſt angle of incidence FHC. The angle BFH, or its equal CFD, is equal to the angles FHD and FCH; that is, the angle of incidence CFD exceeds the next angle of incidence FHC by the angle FCD; that is, by the angle of the cone. In like manner, FDH exceeds CFD by the ſame angle FCD. Thus every ſucceeding angle, either of incidence or reflection, exceeds the next by the angle of the cone. Call the angle of the cone a, and let b be the firſt angle of incidence PDC. The ſecond, or DFC, is $b-a$. The third, or FHC, is $b-2a$, &c.: and the nth angle of incidence or reflection is $b-na$, after n reflections. Since the angle diminiſhes by equal quantities at each ſubſequent reflection, it is plain, that whatever be the firſt angle of incidence, it may be exhauſted by this diminution; namely, when n times a exceeds or is equal to b. Therefore to know how many reflections of a ſound, whoſe firſt incidence has the inclination b, can be made in an infinitely extended cone, whoſe angle is a, divide b by a; the quotient will give the number n of reflections, and the remainder, if any, will be the laſt angle of incidence or reflection leſs than a. It is very plain, that when an angle of reflection IHA is equal to or leſs than the angle BCA of the cone, the reflected line HI will no more meet with the other ſide CB of the cone.

We may here obſerve, that the greateſt angle of incidence is a right angle, or 90°. This ſound would be reflected back in the ſame line, and would be incident on the oppoſite ſide in an angle $=90^\circ-a$, &c.

Thus we ſee that a conical trumpet is well ſuited for confining the ſound: for by prolonging it ſufficiently, we can keep the lines of reflected ſound wholly within the cone. And when it is not carried to ſuch a length as to do this, when it allows the ſounding line GH, for example, to eſcape without farther reflection, the divergency from the axis is leſs than the laſt angle of reflection BGH by half the angle BCA of the cone. Let us ſee what is the connection between the length and the angle of ultimate reflection.

We have $\text{ſin.}\,\overline{b-a} : \text{ſin.}\,b = \text{CD} : \text{CF}$, and $\text{CF} = \text{CD} \times \frac{\text{ſin.}\,b}{\text{ſin.}\,\overline{b-a}}$, and $\text{ſin.}\,\overline{b-2a} : \text{ſin.}\,\overline{b-a} = \text{CF} : \text{CH}$, and $\text{CH} = \text{CF} \times \frac{\text{ſin.}\,b-a}{\text{ſin.}\,\overline{b-2a}} = \text{CD} \times \frac{\text{ſin.}\,b}{\text{ſin.}\,\overline{b-a}} \times \frac{\text{ſin.}\,\overline{b-a}}{\text{ſin.}\,\overline{b-2a}}, = \text{CD} \times \frac{\text{ſin.}\,b}{\text{ſin.}\,\overline{b-2a}}$, &c.

Therefore if we ſuppoſe X to be the length which will give us n reflections, we ſhall have $\text{X} = \text{CD} \times \frac{\text{ſin.}\,b}{\text{ſin.}\,\overline{b-na}}$. Hence we ſee that the length increaſes as the angle $\overline{b-na}$ diminiſhes; but is not infinite, unleſs na is equal to b. In this caſe, the immediately preceding angle of reflection muſt be a, becauſe theſe angles have the common difference a. Therefore the laſt reflected ſound was moving parallel to the oppoſite ſide of the cone, and cannot again meet it. But though we cannot aſſign the length which will give the nth reflection, we can give the length which will give the one immediately preceding, whoſe angle with the ſide of the cone is a. Let Y be this length. We have $\text{Y} = \text{CD} \times \frac{\text{ſin.}\,b}{\text{ſin.}\,a}$. This length will allow every line of ſound to be reflected as often, ſaving once, as if the tube were infinitely long. For ſuppoſe a ſonorous line to be traced backwards, as if a ſound entered the tube in the direction ih, and were reflected in the points h, f, d, δ, D, the angles will be continually augmented by the conſtant angle a. But this augmentation can never go farther than $90^\circ+\frac{1}{2}a$. For if it reaches that value at D, for inſtance, the reflected line DK will be perpendicular to the axis CN; and the angle ADK will be equal to the angle DKB, and the ſound will come out again. This remark is of importance on another account.

Now ſuppoſe the cone to be cut off at D by a plane perpendicular to the axis, KD will be the diameter of its mouth-piece; and if we ſuppoſe a mouth completely occupying this circle, and every point of the circle to be ſonorous, the reflected ſounds will proceed from it in the ſame manner as light would from a flame which completely

completely occupies its area, and is reflected by the inſide of the cone. The angle FDA will have the greateſt poſſible ſine when it is a right angle, and it never can be greater than ADK, which is $=90+\frac{1}{2}a$. And ſince between $90^\circ+\frac{1}{2}a$, and $90-\frac{1}{2}a$, there muſt fall ſome multiple of a; call this multiple b. Then, in order that every ſound may be reflected as often as poſſible, ſaving once, we muſt make the length of it $X=CD\times\frac{S,b}{S,a}$.

Now ſince the angle of the cone is never made very great, never exceeding 10 or 12 degrees, b can never differ from 90 above a degree or two, and its ſine cannot differ much from unity. Therefore X will be very nearly equal to $\frac{CD,}{S,a}$ which is alſo very nearly equal to $\frac{CD}{2S,\frac{1}{2}a}$; becauſe a is ſmall, and the ſines of ſmall arches are nearly equal and proportional to the arches themſelves. There is even a ſmall compenſation of errors in this formula. For as the ſine of 90° is ſomewhat too large, which would give X too great, $2S,\frac{1}{2}a$ is alſo larger than the ſine of a. Thus let a be 12°: then the neareſt multiple of a is 84 or 96°, both of which are as far removed as poſſible from 90°, and the error is as great as poſſible, and is nearly $\frac{1}{100}$th of the whole.

This approximation gives us a very ſimple conſtruction. Let CM be the required length of the trumpet, and draw ML perpendicular to the axis in O. It is evident that S, MCO : rad. $=$MO : CM, and CM; or $X=\frac{MO}{S,\frac{1}{2}a}=\frac{LM}{2S,\frac{1}{2}a}$, but $X=\frac{CD}{2S,\frac{1}{2}a}$, and therefore LM is equal to CD.

If therefore the cone be of ſuch a length, that its diameter at the mouth is equal to the length of the part cut off, every line of ſound will have at leaſt as many reflections, ſave one, as if the cone were infinitely long; and the laſt reflected line will either be parallel to the oppoſite ſide of the cone, or lie nearer the axis than this parallel; conſequently ſuch a cone will confine all the reflected ſounds within a cone whoſe angle is $2a$, and will augment the ſound in the proportion of the ſpherical baſe of this cone to a complete hemiſpherical ſurface. Deſcribe the circle DKT round C, and making DT an arch of 90, draw the chord DT. Then ſince the circles deſcribed with the radii DK, DT, are equal to the ſpherical ſurfaces generated by the revolution of the arches DK and DKT round the axis CD, the ſound will be condenſed in the proportion of DK^2 to DT^2.

This appears to be the beſt general rule for conſtructing the inſtrument; for, to procure another reflection, the tube muſt be prodigiouſly lengthened, and we cannot ſuppoſe that one reflection more will add greatly to its power.

It appears, too, that the length depends chiefly on the angle of the cone; for the mouth piece may be conſidered as nearly a fixed quantity. It muſt be of a ſize to admit the mouth when ſpeaking with force and without conſtraint. About an inch and a half may be fixed on for its diameter. When therefore we propoſe to confine the ſound to a cone of twice the angle of the trumpet, the whole is determined by that angle. For ſince in this caſe LM is equal to CD, we have DK : CD$=$LM (or CD) : CM and $CM=\frac{CD^2}{DK}$.

$$\begin{array}{ll} \text{But} & 2S,\tfrac{1}{2}a : 1=DK : CD, \\ \text{and} & 2S,\tfrac{1}{2}a : 1=CD : CM; \\ \text{therefore} & 4S,^2\tfrac{1}{2}a : 1=DK : CM, \end{array}$$

And $CM=\frac{DK}{4S,^2\frac{1}{2}a},=\frac{DK}{S,^2a}$ very nearly. And ſince DK is an inch and a half, we get the length in inches, counted from the apex of the cone $=\frac{1\frac{1}{2}}{S,^2a}$, or $\frac{3}{2S,^2a}$. From this we muſt cut off the part CD, which is $=\frac{DK,}{S,\frac{1}{2}a}$, or very nearly $\frac{DK}{S,a}$, or $\frac{3}{2S,a}$, meaſured in inches, and we muſt make the mouth of the ſame width $\frac{3}{2S,a}$.

On the other hand, if the length of the trumpet is fixed on, we can determine the angle of the cone. For let the length (reckoned from C) be L; we have $2S,^2a=\frac{3}{L}$, or $S,^2a=\frac{3}{2L}$, and $S,a=\sqrt{\frac{3}{2L}}$.

Thus let 6 feet or 72 inches be choſen for the length of the cone, we have $S,a=\sqrt{\frac{3}{144}}=\sqrt{\frac{1}{48}},=0{,}14434,=$ſin 8° 17′ for the angle of the cone; and the width at the mouth is $\frac{3}{2,S,a}=10{,}4$ inches. This being taken from 72, leaves 61,6 inches for the length of the trumpet.

And ſince this trumpet confines the reflected ſounds to a cone of $16^\circ 34'$, we have its magnifying power $=\frac{DT^2}{DK^2},=\frac{\frac{1}{2}DT^2}{\frac{1}{2}DK^2}=\frac{S,^2 45^\circ}{S,^2 4^\circ 8'\frac{1}{2}}=96$ nearly. It therefore condenſes the ſound about 96 times; and if the diſtribution were uniform, it would be heard $\sqrt{96}$, or nearly 10 times farther off. For the loudneſs of ſounds is ſuppoſed to be inverſely as the ſquare of the diſtance from the centre of undulation.

But before we can pronounce with preciſion on the performance of a ſpeaking trumpet, we muſt examine into the manner in which the reflected ſounds are diſtributed over the ſpace in which they are all confined.

Fig. 3.

Let BKDA (fig. 3.) be the ſection of a conical trumpet by a plane through the axis; let C be the vertex of the cone, and CW its axis; let TKV be the ſection of a ſphere, having its centre in the vertex of the cone; and let P be a ſonorous point on the ſurface of the ſphere, and P *a f e l* the path of a line of ſound lying in the plane of the ſection.

In the great circle of the ſphere take KQ$=$KP, DR $=$DQ, and KS$=$KR. Draw QB*h*; alſo draw Q*dn* parallel to DA; and draw PB, P*d*, PA.

1. Then it is evident that all the lines drawn from P, within the cone APB, proceed without reflection, and are diffuſed as if no trumpet had been uſed.

2. All the ſonorous lines which fall from P on KB are reflected from it as if they had come from Q.

3. All the ſonorous lines between BP and dP have ſuffered but one reflection; for dn will no more meet DAA′ ſo as to be reflected again.

4. All the lines which have been reflected from KB, and afterwards from DA, proceed as if they had come from R. For the lines reflected from KB proceed as if they had come from Q; and lines coming from Q and reflected by DA, proceed as if they had come from R. Therefore draw RAo, and alſo draw Rgm parallel to KB, and draw QcAq, Qbg, Pc, and Pb. Then,

5. All the lines between bP and cP have been twice reflected.

Again, draw SBp, BrR, ruQ, SxA, Ryx, Qzy.

6. All the lines between uP and zP have ſuffered three reflections.

Draw the tangents TAt, VBv, croſſing the axis in W.

7. The whole ſounds will be propagated within the cone vWt. For to every ſonorous point in the line KD there correſponds a point ſimilar to Q, regulating the firſt reflection from KB; and a point ſimilar to R, regulating the ſecond reflection from DA; and a point S regulating the third reflection from KB, &c. And ſimilar points will be found regulating the firſt reflection from DA, the ſecond from KB, and the third from DA, &c.; and lines drawn from all theſe through A and B muſt lie within the tangents TA and VB.

8. Thus the centres of reflection of all the ſonorous lines which lie in planes paſſing through the axis, will be found in the ſurface of this ſphere; and it may be conſidered as a ſonorous ſphere, whoſe ſounds firſt concentrate in W, and are then diffuſed in the cone vWt.

It may be demonſtrated nearly in the ſame manner, that the ſonorous lines which proceed from P, but not in the plane paſſing through the axis, alſo proceed, after various reflections, as if they had come from points in the ſurface of the ſame ſphere. The only difference in the demonſtration is, that the centres Q, R, S of the ſucceſſive reflections are not in one plane, but in a ſpiral line winding round the ſurface of the ſphere according to fixed laws. The foregoing concluſions are therefore general for all the ſounds which come in all directions from every point in the area of the mouth-piece.

Thus it appears, that a conical trumpet is well fitted for increaſing the force of ſounds by diminiſhing their final divergence. For had the ſpeaker's mouth been in the open air, the ſounds which are now confined within the cone vWt would have been diffuſed over a hemiſphere: and we ſee that prolonging the trumpet muſt confine the ſounds ſtill more, becauſe this will make the angle BWA ſtill ſmaller; a longer tube muſt alſo occaſion more reflections, and conſequently ſend more ſonorous undulations to the ear at a diſtance placed within the cone vWt.

We have now obtained a very connected view of the whole effect of a conical trumpet. It is the ſame as if the whole ſegment TKDV were ſounding, every part of it with an intenſity proportional to the denſity of the points Q, R, S, &c. correſponding to the different points P of the mouth-piece. It is eaſy to ſee that this cannot be uniform, but muſt be much rarer towards the margin of the ſegment. It would require a good deal of diſcuſſion to ſhow the denſity of theſe fictitious ſounding points; and we ſhall content ourſelves with giving a very palpable view of the diſtribution of the ſonorous rays, or the denſity (ſo to ſpeak) of the echoes, in the different ſituations in which a hearer may be placed.

We may obſerve, in the mean time, that this ſubſtitution of a ſounding ſphere for the ſounding mouth-piece has an exact parallel in OPTICS, by which it will be greatly illuſtrated. Suppoſe the cone BKDA (fig. 3.) to be a tube poliſhed in the inſide, fixed in a wall Bα, perforated in BA, and that the mouth-piece DK is occupied completely by a flat flame. The effect of this on a ſpectator will be the ſame, if he is properly placed in the axis, as if he were looking at a flame as big as the whole ſphere. This is very evident.

Fig. 3.

It is eaſy to ſee that the line leS is equal to the line $lefa$P; therefore the reflected ſounds alſo come to the ear in the ſame moments as if they had come from their reſpective points on the ſurface of the ſubſtituted ſphere. Unleſs, therefore, this ſphere be enormouſly large, the diſtinctneſs of articulation will not be ſenſibly affected, becauſe the interval between the arrival of the different echoes of the ſame ſnap will be inſenſible.

Our limits oblige us to content ourſelves with exhibiting this evident ſimilarity of the progreſs of echo from the ſurface of this phonic ſphere, to the progreſs of light from the ſame luminous ſphere ſhining through a hole of which the diameter is AB. The direct inveſtigation of the intenſity of the ſound in different directions and diſtances would take up much room, and give no clearer conception of the thing. The intenſity of the ſound in any point is preciſely ſimilar to the intenſity of the illumination of the ſame point; and this is proportional to the portion of the luminous ſurface ſeen from this point through the hole directly, and to the ſquare of the diſtance inverſely. The intelligent reader will acquire a diſtinct conception of this matter from fig. 4. which repreſents the diſtribution of the ſonorous lines, and by conſequence the degree of loudneſs which may be expected in the different ſituations of the hearer.

As we have already obſerved, the effect of the cone of the trumpet is perfectly analogous to the reflection of light from a poliſhed concave, conical mirror. Such an inſtrument would be equally fitted for illuminating a diſtant object. We imagine that theſe would be much more powerful than the ſpherical or even parabolic mirrors commonly uſed for this purpoſe. Theſe laſt, having the candle in the focus, alſo ſend forward a cylinder of light of equal width with the mirror. But it is well known, that oblique reflections are prodigiouſly more vivid than thoſe made at greater angles. Where the inclination of the reflected light to the plane of the mirror does not exceed eight or ten degrees, it reflects about three-fourths of the light which falls on it. But when the inclination is 80, it does not reflect one-fourth part.

Fig. 4.

We may alſo obſerve, that the denſity of the reflected ſounds by the conical trumpet ABC (fig. 4.) is preciſely ſimilar to that of the illumination produced by a luminous ſphere TDV, ſhining through a hole AB. There will be a ſpace circumſcribed by the cone formed by the lines TBt and VAv, which is uniformly illuminated by the whole ſphere (or rather by the ſegment TDV), and on each ſide there is a ſpace illuminated by

Articulate TRUMPET. Plate DXXXIX

Fig. 1.

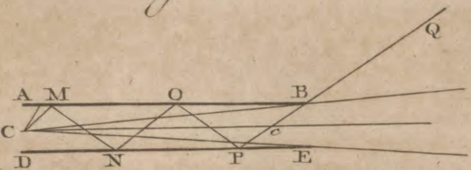


Fig. 2.

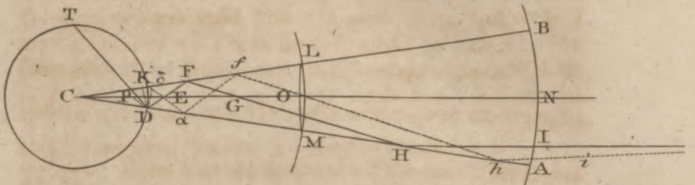


Fig. 3.

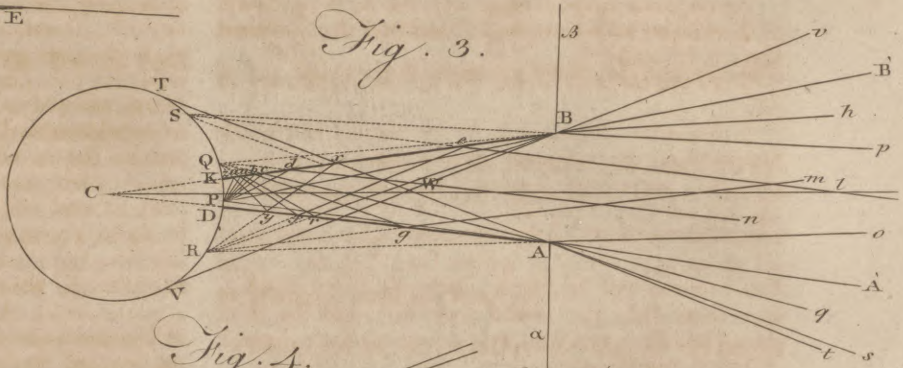


Fig. 4.

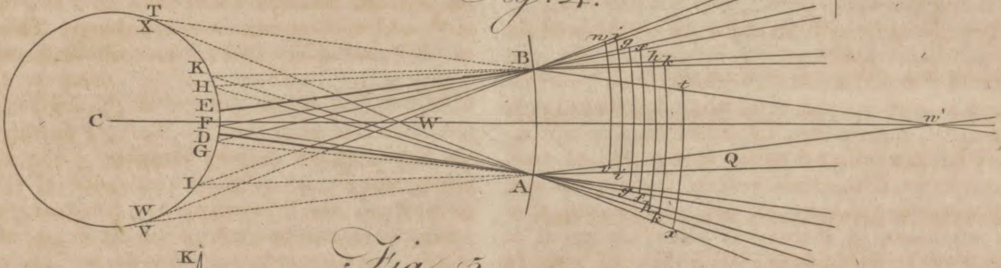


Fig. 5.

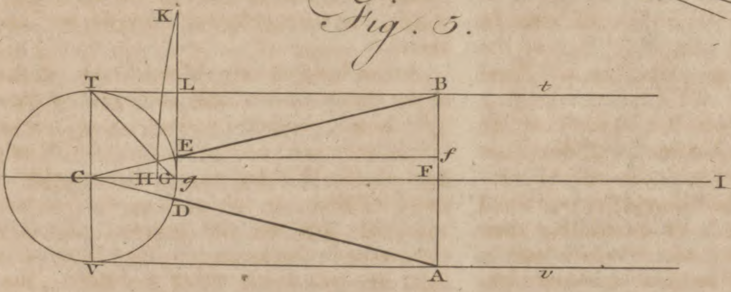


Fig. 7.

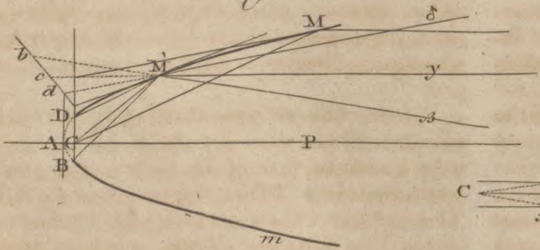
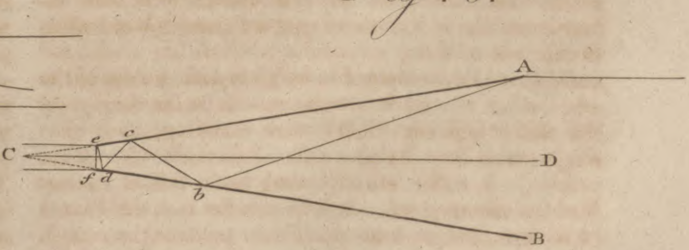


Fig. 6.



W. Train Sculp.t

a part of it only, and the illumination gradually decreaſes towards the borders. A ſpectator placed much out of the axis, and looking through the hole AB, may not ſee the whole ſphere. In like manner, he will not hear the whole ſounding ſphere: He may be ſo far from the axis as neither to ſee nor hear any part of it.

Aſſiſting our imagination by this compariſon, we perceive that beyond the point w' there is no place where *all* the reflected ſounds are heard. Therefore, in order to preſerve the magnifying power of the trumpet at any diſtance, it is neceſſary to make the mouth as wide as the ſonorous ſphere. Nay, even this would be an imperfect inſtrument, becauſe its power would be confined to a very narrow ſpace; and if it be not accurately pointed to the perſon liſtening, its power will be greatly diminiſhed. And we may obſerve, by the way, that we derive from this circumſtance a ſtrong confirmation of the juſtneſs of Mr Lambert's principles; for the effects of ſpeaking trumpets are really obſerved to be limited in the way here deſcribed.—Parabolic trumpets have been made, and they fortify the ſound not only in the cylindrical ſpace in the direction of the axis, but alſo on each ſide of it, which ſhould not have been the caſe had their effect depended only on the undulations formed by the parabola in planes perpendicular to the axis. But to proceed.

Fig. 5. Let BCA (fig. 5.) be the cone, ED the mouth-piece, TEDV the equivalent ſonorous ſphere, and TBAV the circumſcribed cylinder. Then CA or CB is the length of cone that is neceſſary for maintaining the magnifying power at all diſtances. We have two conditions to be fulfilled. The diameter ED of the mouth-piece muſt be of a certain fixed magnitude, and the diameter AB of the outer end muſt be equal to that of the equivalent ſonorous ſphere. Theſe conditions determine all the dimenſions of the trumpet and its magnifying power. And, firſt, with reſpect to the dimenſions of the trumpet.

The ſimilarity of the triangles ECG and BCF gives $CG : ED = CF : AB$; but $CG = BF, = \frac{1}{2}AB$, and $CF = CG + GF, = GF + \frac{1}{2}AB$; therefore $\frac{1}{2}AB : ED = GF + \frac{1}{2}AB : AB$, and $AB : ED = 2GF + AB : AB$; therefore $2GF \times ED + AB \times ED = AB^2$, and $2GF \times ED = AB^2, - AB \times ED, = AB \times \overline{AB - ED}$, and $GF = \frac{AB \times \overline{AB - ED}}{2ED}$. And, on the other hand, becauſe $AB^2 - \times EBAD = 2GF \times ED$, we have $AB^2 - AB \times ED + \frac{1}{4}ED^2 = 2GF \times ED + \frac{1}{4}ED^2$, or $\overline{AB - \frac{1}{2}ED}^2 = 2GF \times ED + \frac{1}{4}ED^2$, and $AB = \sqrt{2GF \times ED + \frac{1}{4}ED^2} + \frac{1}{2}ED$.

Let x repreſent the length of the trumpet, y the diameter at the great end, and m the diameter of the mouth-piece. Then $x = \frac{y \times \overline{y - m}}{2m}$, and $y = \sqrt{2xm + \frac{1}{4}m^2} + \frac{1}{2}m$. Thus the length and the great diameter may be had reciprocally. The uſeful caſe in practice is to find the diameter for a propoſed length, which is gotten by the laſt equation.

Now if we take all the dimenſions in inches, and fix m at an inch and a half, we have $2xm = 3x$, and $\frac{1}{4}m^2 = 0{,}5625$, and $\frac{1}{2}m = 0{,}75$; ſo that our equation becomes $y = \sqrt{3x + 0{,}5625} + 0{,}75$. The following table gives the dimenſions of a ſufficient variety of trumpets. The firſt column is the length of the trumpet in feet; the ſecond column is the diameter of the mouth in inches; the third column is the number of times that it magnifies the ſound; and the fourth column is the number of times that it increaſes the diſtance at which a man may be diſtinctly heard by its means; the fifth contains the angle of the cone.

GF feet.	AB inches.	Magnifying.	Extending.	ACB.
				° ′
1	6.8	42.6	6.5	24.53
2	9.3	77.8	8.8	18.23
3	11.2	112.4	10.6	15.18
4	12.8	146.6	12.1	13.24
5	14.2	180.4	13.4	12.04
6	15.5	214.2	14.6	11.05
7	16.6	247.7	15.7	10.18
8	17.7	281.3	16.8	9.40
9	18.8	314.6	17.7	9.08
10	19.8	347.7	18.6	8.42
11	20.7	380.9	19.5	8.18
12	21.5	414.6	20.4	7.58
15	24.	513.6	22.7	7.09
18	26.2	612.3	24.7	6.33
21	28.3	711.2	26.6	6.05
24	30.2	810.1	28.5	5.42
ED in all is $= 1.5$				

The two laſt columns are conſtructed on the following conſiderations: We conceive the hearer placed within the cylindrical ſpace whoſe diameter is BA. In this ſituation he receives an echo coming apparently from the whole ſurface TGV; and we account the effect of the trumpet as equivalent to the united voices of as many mouths as would cover this ſurface. Therefore the quotient obtained by dividing the ſurface of the hemiſphere by that of the mouth-piece will expreſs the magnifying power of the trumpet. If the chords gE, gT, be drawn, we know that the ſpherical ſurfaces TgV, EgD, are reſpectively equal to the circles deſcribed with the radii Tg, Eg, and are therefore as Tg^2 and Eg^2. Therefore the audibility of the trumpet, when compared with a ſingle voice, may be expreſſed by $\frac{Tg^2}{Eg^2}$. Now the ratio of Tg^2 to Eg^2 is eaſily obtained. For if Ef be drawn parallel to the axis, it is plain that $Bf = \frac{BA - ED}{2}$, and that Ef is to fB as radius to the tangent of BCF; which angle we may call a. Therefore tan. $a = \frac{y - m}{2x}$, and thus we obtain the angle a. But if the radius CE be accounted 1, Tg is $= \sqrt{2}$, and Eg is $= 2$ ſin. $\frac{a}{2}$. Therefore $\frac{Tg}{Eg} = \frac{\sqrt{2}}{2 \text{ ſin.} \frac{a}{2}}$, and the magnifying power of the trumpet is $= \frac{2}{4 \text{ ſin.}^2 \frac{a}{2}}$,

$= \frac{1}{2\,\text{ſin.}^2 \frac{a}{2}}$. The numbers, therefore, in the third column of the table are each $= \frac{1}{2\,\text{ſin.}^2 \frac{a}{2}}$.

But the more uſual way of conceiving the power of the trumpet is, by conſidering how much farther it will enable us to hear a voice equally well. Now we ſuppoſe that the audibility of ſounds varies in the inverſe duplicate ratio of the diſtance. Therefore if the diſtance d, at which a man may be diſtinctly heard, be increaſed to z, in the proportion of EG to Tg, the ſound will be leſs audible, in the proportion of $\text{T}g^2$ to EG^2. Therefore the trumpet will be as well heard at the diſtance z as the ſimple voice is heard at the diſtance d. Therefore $\frac{z}{d}$ will expreſs the *extending power* of the trumpet, which is therefore $= \frac{\sqrt{2}}{2\,\text{ſin.} \frac{a}{2}}$ In this manner were the numbers computed for the fourth column of the table.

When the angle BCA is ſmall, which is always the caſe in ſpeaking trumpets, we may, without any ſenſible error, conſider EG as $= \frac{\text{ED}}{2}, = \frac{m}{2}$. And $\text{TG} = \text{TC} \times \sqrt{2}, = \frac{\text{AB}}{2} \sqrt{2} = \frac{\text{AB}}{\sqrt{2}} = \frac{y}{\sqrt{2}}$. This gives a very eaſy computation of the extending and magnifying powers of the trumpet.

The extending power is $= \sqrt{2}\, \frac{y}{m}$.

The magnifying power is $= 2\, \frac{y^2}{m^2}$.

We may alſo eaſily deduce from the premiſes, that if the mouth-piece be an inch and a half in diameter, and the length x be meaſured in inches, the extending power is very nearly $= \sqrt{\tfrac{8}{3} x}$ and the magnifying power $= \tfrac{8}{3} x$.

An inconvenience ſtill attends the trumpet of this conſtruction. Its complete audibility is confined to the cylindrical ſpace in the direction of the axis, and it is more faintly heard on each ſide of it. This obliges us to direct the trumpet very exactly to the ſpot where we wiſh it to be heard. This is confirmed by all the accounts we have of the performance of great ſpeaking trumpets. It is evident, that by lengthening the trumpet, and therefore enlarging its mouth, we make the lines TB t and VA v expand (fig. 4.); and therefore it will not be ſo difficult to direct the trumpet.

Fig. 4.

But even this is confined within the limits of a few degrees. Even if the trumpet were continued without end, the ſounds cannot be reinforced in a wider ſpace than the cone of the trumpet. But it is always advantageous to increaſe its length; for this makes the extreme tangents embrace a greater portion of the ſonorous ſphere, and thus increaſes the ſound in the ſpace where it is all reflected. And the limiting tangents TB, VA, expand ſtill more, and thus the ſpace of full effect is increaſed. But either of theſe augmentations is very ſmall in compariſon of the augmentation of ſize. If the trumpet of fig. 5. were made an hundred times longer, its power would not be increaſed one half.

We need not therefore aim at much more than to produce a cylindrical ſpace of full effect; and this will always be done by the preceding rules, or table of conſtructions. We may give the trumpet a third or a fourth part more length, in order to ſpread a little the ſpace of its full effect, and thereby make it more eaſily directed to the intended object. But in doing this we muſt be careful to increaſe the diameter of the mouth as much as we increaſe the length; otherwiſe we produce the very oppoſite effect, and make the trumpet greatly inferior to a ſhorter one, at all diſtances beyond a certain point. For by increaſing the length while the part CG remains the ſame, we cauſe the tangents TB and VA to meet on ſome diſtant point, beyond which the ſound diffuſes prodigiouſly. The conſtruction of a ſpeaking trumpet is therefore a problem of ſome nicety; and as the trials are always made at ſome conſiderable diſtance, it may frequently happen that a trumpet which is not heard at a mile's diſtance, may be made very audible two miles off by cutting off a piece at its wide end.

After this minute conſideration of the conical trumpet, we might proceed to conſider thoſe of other forms. In particular, the hyperbolic, propoſed by Caſſegrain, and the parabolic, propoſed by Haaſe, ſeem to merit conſideration. But if we examine them merely as reflectors of echoes, we ſhall find them inferior to the conical.

With reſpect to the hyperbolic trumpet, its inaptitude is evident at firſt ſight. For it muſt diſſipate the echoes more than a conical trumpet. Indeed Mr Caſſegrain proceeds on quite different principles, depending on the mechaniſm of the aerial undulations: his aim was to increaſe the agitation in each pulſe, ſo that it may make a more forcible impulſe on the ear. But we are too imperfectly acquainted with this ſubject to decide *a priori*; and experience ſhows that the hyperbola is not a good form.

With reſpect to the parabolic trumpet, it is certain that if the mouth-piece were but a point, it would produce the moſt favourable reflection of all the ſounds; for they would all proceed parallel to the axis. But every point of an open mouth muſt be conſidered as a centre of ſound, and none of it muſt be kept out of the trumpet. If this be all admitted, it will be found that a conical trumpet, made by the preceding rules, will diſſipate the reflected ſounds much leſs than the parabolic.

Thus far have we proceeded on the fair conſequences of the well known fact, that echoes are reflected in the ſame manner as light, without engaging in the intricate inveſtigation of aerial undulations. Whoever conſiders the Newtonian theory of the propagation of ſound with intelligence and attention, will ſee that it is demonſtrated ſolely in the caſe of a ſingle row of particles; and that all the general corollaries reſpecting the lateral diffuſion of the elaſtic undulations are little more than ſagacious gueſſes, every way worthy of the illuſtrious author, and beautifully confirmed by what we can moſt diſtinctly and accurately obſerve in the circular waves on the ſurface of ſtill water. But they are by no means fit for becoming the foundation of any doctrine which lays the ſmalleſt claim to the title of accurate ſcience. We really know

know exceedingly little of the theory of aerial undulations; and the conformity of the phenomena of ſound to theſe gueſſes of Sir Iſaac Newton has always been a matter of wonder to every eminent and candid mathematician: and no other ſhould pretend to judge of the matter. This wonder has always been acknowledged by Daniel Bernoulli; and he is the only perſon who has made any addition to the ſcience of ſounds that is worth mentioning. For ſuch we muſt always eſteem his doctrine of the ſecondary undulations of muſical cords, and the ſecondary pulſes of air in pipes. Nothing therefore is more unwarrantable, or more plainly ſhows the precipitant preſumption of modern ſcioliſts, than the familiar uſe of the general theory of aerial undulations in their attempts to explain the abſtruſe phenomena of nature (ſuch as the communication of ſenſation from the organ to the ſenſorium by the vibrations of a nervous fluid, the reciprocal communication of the volitions from the ſenſorium to the muſcle, nay, the whole phenomena of mind), by vibrations and vibratiunculæ.

Such attempts equally betray ignorance, preſumption, and meanneſs of ſoul. Ignorance of the extent to which the Newtonian theory may be logically carried, is the neceſſary conſequence of ignorance of the theory itſelf. It is preſumption to apply it to the phenomena of the intellectual world; and ſurely he has an abject ſoul who hugs and cheriſhes the humble thought, that his mind is an undulating fluid, and that its all-graſping comprehenſion, and all its delightful emotions, are nothing more than an etherial tune.—"Pol me occidiſtis amentes." This whim is older than Hartley: It may be found in Robinet's *Syſteme de la Nature*. This by the bye made its firſt appearance as a diſcourſe delivered by Brother Orateur in the lodge of the grand Orient at Lyons; from which ſource have proceeded all the coſmopolitical ſocieties in Europe, and that illumination by which reaſon is to triumph over revelation, and liberty and equality over civil government. We crave pardon of our readers for this ebullition of ſpleen; and we hope for it from all thoſe who can read Newton, and who eſteem his modeſty.

Thoſe who have endeavoured to improve the ſpeaking trumpet on mechanical principles, have generally aimed at increaſing the violence of the elaſtic undulations, that they may make a more forcible impulſe on the ear. This is the object in view in the parabolic trumpet. All the undulations are converted into others which are in planes perpendicular to the axis of the inſtrument; ſo that the ſame little maſs of air is agitated again and again in the ſame direction. From this it is obvious to conclude, that the total agitation will be more violent. But, in the firſt place, theſe violent agitations muſt diffuſe themſelves laterally as ſoon as they get out of the trumpet, and thus be weakened, in a proportion that is perhaps impoſſible for the moſt expert analyſt to determine. But, moreover, we are not ſufficiently acquainted with the mechaniſm of the very firſt agitations, to be able to perceive what conformation of the trumpet will cauſe the reflected undulations to increaſe the firſt undulations, or to check them. For it muſt happen, during the production of a continued ſound in a trumpet, that a parcel of air, which is in a ſtate of progreſſive agitation, as it makes a pulſe of one ſound, may be in a ſtate of retrograde agitation, as it is part of a pulſe of air producing another ſound. We cannot (at leaſt no mathematician has yet done it) diſcriminate, and then combine theſe agitations, with the intelligence and preciſion that are neceſſary for enabling us to ſay what is the ultimate accumulated effect. Mr Lambert therefore did wiſely in abſtaining from this intricate inveſtigation; and we are highly obliged to him for deducing ſuch a body of demonſtrable doctrine from the acknowledged, but ill underſtood, fact of the reflection of echoes.

We know that two ſounds actually croſs each other without any mutual diſturbance; for we can hear either of them diſtinctly, provided the other is not ſo loud as to ſtun our ears, in the ſame manner as the glare of the ſun dazzles our eyes. We may therefore depend on all the conſequences which are legitimately deduced from this fact, in the ſame manner as we depend on the ſcience of catoptrics, which is all deduced from a fact perfectly ſimilar and as little underſtood.

But the preceding propoſitions by no means explain or comprehend all the reinforcement of ſound which is really obtained by means of a ſpeaking trumpet. In the firſt place, although we cannot tell in what degree the aerial undulations are increaſed, we cannot doubt that the reflections which are made in directions which do not greatly deviate from the axis, do really increaſe the agitation of the particles of air. We ſee a thing perfectly ſimilar to this in the waves on water. Take a long ſlip of lead, about two inches broad, and having bent it into the form of a parabola, ſet it into a large flat trough, in which the water is about an inch deep. Let a quick ſucceſſion of ſmall drops of water fall preciſely on the focus of the parabola. We ſhall ſee the circular waves proceeding from the focus all converted into waves perpendicular to the axis, and we ſhall frequently ſee theſe ſtraight waves conſiderably augmented in their height and force. We ſay generally, for we have ſometimes obſerved that theſe reflected waves were not ſenſibly ſtronger than the circular or original waves. We do not exactly know to what this difference muſt be aſcribed: we are diſpoſed to attribute it to the frequency of the drops. This may be ſuch, that the interval of time between each drop is preciſely equal, or at leaſt commenſurable, to the time in which the waves run over their own breadth. This is a pretty experiment; and the ingenious mechanician may make others of the ſame kind which will greatly illuſtrate ſeveral difficult points in the ſcience of ſounds. We may conclude, in general, that the reflection of ſounds, in a trumpet of the uſual ſhapes, is accompanied by a real increaſe of the aerial agitations; and in ſome particular caſes we find the ſounds prodigiouſly increaſed. Thus, when we blow through a muſical trumpet, and allow the air to take that uniform undulation which can be beſt maintained in it, namely, that which produces its muſical tone, where the whole tube contains but one or two undulations, the agitation of a particle muſt then be very great; and it muſt deſcribe a very conſiderable line in its oſcillations. When we ſuit our blaſt in ſuch a manner as to continue this note, that is, this undulation, we are certain that the ſubſequent agitations conſpire with the preceding agitation, and augment it. And accordingly we find that the ſound is increaſed to a prodigious degree. A cor de chaſſe, or a bugle horn, when properly winded, will almoſt deafen the ear; and yet the exertion is a mere nothing in compariſon with what we make when bellowing with all our force, but with not the tenth part of the noiſe. We alſo know, that if we ſpeak through a ſpeaking trumpet in the key which correſponds with its dimenſions, it is much more audible than when we ſpeak in a different pitch. Theſe obſervations ſhow, that the loudneſs of a ſpeaking trumpet ariſes from ſomething more than the ſole reflection of echoes conſidered by Mr Lambert—the very echoes are rendered louder.

In the next place, the ſounds are increaſed by the vibrations of the trumpet itſelf. The elaſtic matter of the trumpet is thrown into tremors by the undulations which proceed from the mouth-piece. Theſe tremors produce pulſes in the contiguous air, both in the inſide of the trumpet and on that which ſurrounds it. Theſe undulations within the trumpet produce original ſounds, which are added to the reflected ſounds: for the tremor continues for ſome little time, perhaps the time of three or four or more pulſes. This muſt increaſe the loudneſs of the ſubſequent pulſes. We cannot ſay to what degree, becauſe we do not know the force of the tremor which the part of the trumpet acquires: but we know that theſe ſounds will not be magnified by the trumpet to the ſame degree as if they had come from the mouth-piece; for they are reflected as if they had come from the ſurface of a ſphere which paſſes through the agitated point of the trumpet. In ſhort, they are magnified only by that part of the trumpet which lies without them. The whole ſounds of this kind, therefore, proceed as if they came from a number of concentric ſpherical ſurfaces, or from a ſolid ſphere, whoſe diameter is twice the length of the trumpet cone.

All theſe agitations ariſing from the tremors of the trumpet tend greatly to hurt the diſtinctneſs of articulation; becauſe, coming from different points of a large ſphere, they arrive at the ear in a ſenſible ſucceſſion; and thus change a momentary articulation to a lengthened ſound, and give the appearance of a number of voices uttering the ſame words in ſucceſſion. It is in this way, that, when we clap our hands together near a long rail, we get an echo from each poſt, which produces a chirping ſound of ſome continuance. For theſe reaſons it is found advantageous to check all tremors of the trumpet by wrapping it up in woollen liſts. This is alſo neceſſary in the muſical trumpet.

With reſpect to the undulations produced by the tremors of the trumpet in the air contiguous to its outſide, they alſo hurt the articulation. At any rate, this is ſo much of the ſonorous momentum uſeleſsly employed; becauſe they are diffuſed like common ſounds, and receive no augmentation from the trumpet.

Hearing trumpet.

It is evident, that this inſtrument may be uſed (and accordingly was ſo) for aiding the hearing; for the ſonorous lines are reflected in either direction. We know that all tapering cavities greatly increaſe external noiſes; and we obſerve the brutes prick up their ears when they want to hear uncertain or faint ſounds. They turn them in ſuch directions as are beſt ſuited for the reflection of the ſound from the quarter whence the animal imagines that it comes.

Let us apply Mr Lambert's principle to this very intereſting caſe, and examine whether it be poſſible to aſſiſt dull hearing in like manner as the optician has aſſiſted imperfect ſight.

The ſubject is greatly ſimplified by the circumſtances of the caſe; for the ſounds to which we liſten generally come in nearly one direction, and all that we have to do is to produce a conſtipation of them. And we may conclude, that the audibility will be proportional to this conſtipation.

Fig. 6.

Therefore let ACB, fig. 6. be the cone, and CD its axis. The ſound may be conceived as coming in the direction RA, parallel to the axis, and to be reflected in the points A, *b*, *c*, *d*, *e*, till the angle of incidence increaſes to 90°; after which the ſubſequent reflections ſend the ſound out again. We muſt therefore cut off a part of the cone; and, becauſe the lines increaſe their angle of incidence at each reflection, it will be proper to make the angle of the cone an aliquot part of 90°, that the leaſt incidence may amount preciſely to that quantity. What part of the cone ſhould be cut off may be determined by the former principles. Call the angle ACD, a. We have $Ce = \frac{CA \cdot \text{ſin.}\, a}{\text{ſin.}\, (2n+1)\, a}$, when the ſound gets the laſt uſeful reflection. Then we have the diameter of the mouth $AB = 2\, CA \cdot \text{ſin.}\, a$, and that of the other end $ef = Ce \cdot 2\, \text{ſin.}\, a$. Therefore the ſounds will be conſtipated in the ratio of CA^2 to Ce^2, and the trumpet will bring the ſpeaker nearer in the ratio of CA to C*e*.

When the lines of reflected ſound are thus brought together, they may be received into a ſmall pipe perfectly cylindrical, which may be inſerted into the external ear. This will not change their angles of inclination to the axis nor their denſity. It may be convenient to make the internal diameter of this pipe $\frac{1}{3}$ of an inch. Therefore $Ce \cdot \text{ſin.}\, a$ is $= \frac{1}{6}$ of an inch. This circumſtance, in conjunction with the magnifying power propoſed, determines the other dimenſions of the hearing trumpet. For $Ce = \frac{1}{6\, \text{ſin.}\, a} = \frac{CA \cdot \text{ſin.}\, a}{\text{ſin.}\, (2n+1) a}$, and CA $= \frac{\text{ſin.}\, (2n+1\, a)}{6\, \text{ſin.}^2\, a}$.

Thus the relation of the angle of the cone and the length of the inſtrument is aſcertained, and the ſound is brought nearer in the ratio of CA to C*e*, or of ſin. $(2n+1)\, a$ to ſin. a. And ſeeing that we found it proper to make $(2n+1)\, a = 90°$, we obtain this very ſimple analogy, $1 : \text{ſin.}\, a = CA : Ce$. And the ſine of $\frac{1}{2}$ the angle of the cone is to radius as 1 to the approximating power of the inſtrument.

Thus let it be required that the ſound may be as audible as if the voice were 12 times nearer. This gives $\frac{CA}{Ce} = 12$. This gives ſin. $a = \frac{1}{12}$, and $a = 4°47'$, and the angle of the cone $= 9.34$. Then $CA = \frac{1}{6\, \text{ſin.}^2\, a} = \frac{1}{6 \frac{1}{144}} = \frac{144}{6}, = 24$. Therefore the length of the cone is 24 inches. From this take $Ce = \frac{CA}{12} = 2$, and the length of the trumpet is 22 inches. The diameter at the mouth is $2\, Ce, = 4$ inches. With this inſtrument one voice ſhould be as loud as 144.

If it were required to approximate the ſound only four times, making it 16 times ſtronger than the natural voice.

voice at the ſame diſtance, the angle ACB muſt be 29°; A*e* muſt be 2 inches, AB muſt be $1\frac{1}{3}$d inches, and *ef* muſt be $\frac{1}{3}$d of an inch.

It is eaſy to ſee, that when the ſize of the ear-end is the ſame in all, the diameters at the outer end are proportional to the approximating powers, and the lengths of the cones are proportional to the magnifying powers.

We ſhall find the parabolic conoid the preferable ſhape for an acouſtic trumpet; becauſe the ſounds come into the inſtrument in a direction parallel to the axis, they are reflected ſo as to paſs through the focus. The parabolic conoid muſt therefore be cut off through the focus, that the ſounds may not go out again by the ſubſequent reflections; and they muſt be received into a cylindrical pipe of one-third of an inch in diameter. Therefore the parameter of this parabola is one-ſixth of an inch, and the focus is one-twelfth of an inch from the vertex. This determines the whole inſtrument; for they are all portions of one parabolic conoid. Suppoſe that the inſtrument is required to approximate the ſound 12 times, as in the example of the conical inſtrument. The ordinate at the mouth muſt be 12 times the 6th of an inch, or 2 inches; and the mouth diameter is four inches, as in the conical inſtrument. Then, for the length, obſerve, that DC in fig. 7. is $\frac{1}{6}$th of an inch, and MP is 2 inches, and AC is $\frac{1}{12}$th of an inch, and $DC^2 : MP^2 = AC : AP$. This will give $AP = 12$ inches, and $CP = 11\frac{11}{12}$ths; whereas in the conical tube it was 22. In like manner an inſtrument which approximates the ſounds four times, is only $1\frac{1}{3}$d inches long, and $1\frac{1}{3}$d inches diameter at the big end. Such ſmall inſtruments may be very exactly made in the parabolic form, and are certainly preferable to the conical. But ſince even theſe are of a very moderate ſize when intended to approximate the ſound only a few times, and as they can be accurately made by any tinman, they may be of more general uſe. One of 12 inches long, and 3 inches wide at the big end, ſhould approximate the ſound at leaſt 9 times.

Fig. 7.

A general rule for making them.—Let *m* expreſs the approximating power intended for the inſtrument. The length of the inſtrument in inches is $\frac{m \times \overline{m-1}}{6}$, and the diameter at the mouth is $\frac{m}{3}$. The diameter at the ſmall end is always one-third of an inch.

In trumpets for aſſiſting the hearing, all reverberation of the trumpet muſt be avoided. It muſt be made thick, of the leaſt elaſtic materials, and covered with cloth externally. For all reverberation laſts for a ſhort time, and produces new ſounds which mix with thoſe that are coming in.

We muſt alſo obſerve, that no acouſtic trumpet can ſeparate thoſe ſounds to which we liſten from others that are made in the ſame direction. All are received by it, and magnified in the ſame proportion. This is frequently a very great inconvenience.

There is alſo another imperfection, which we imagine cannot be removed, namely, an odd confuſion, which cannot be called indiſtinctneſs, but a feeling as if we were in the midſt of an echoing room. The cauſe ſeems to be this: Hearing gives us ſome perception of the direction of the ſounding object, not indeed very preciſe, but ſufficiently ſo for moſt purpoſes. In all inſtruments which we have deſcribed for conſtipating ſounds, the laſt reflections are made in directions very much inclined to the axis, and inclined in many different degrees. Therefore they have the appearance of coming from different quarters; and inſtead of the perception of a ſingle ſpeaker, we have that of a ſounding ſurface of great extent. We do not know any method of preventing this, and at the ſame time increaſing the ſound.

There is an obſervation which it is of importance to make on this theory of acouſtic inſtruments. Their performance does not ſeem to correſpond to the computations founded on the theory. When they are tried, we cannot think that they magnify ſo much: Indeed it is not eaſy to find a meaſure by which we can eſtimate the degrees of audibility. When a man ſpeaks to us at the diſtance of a yard, and then at the diſtance of two yards, we can hardly think that there is any difference in the loudneſs; though theory ſays, that it is four times leſs in the laſt of the two experiments; and we cannot but adhere to the theory in this very ſimple caſe, and muſt attribute the difference to the impoſſibility of meaſuring the loudneſs of ſounds with preciſion. And becauſe we are familiarly acquainted with the ſound, we can no more think it four times leſs at twice the diſtance, than we can think the viſible appearance of a man four times leſs when he is at quadruple diſtance. Yet we can completely convince ourſelves of this, by obſerving that he covers the appearance of four men at that diſtance. We cannot eaſily make the ſame experiment with voices.

But, beſides this, we have compared two hearing trumpets, one of which ſhould have made a ſound as audible at the diſtance of 40 feet as the other did at 10 feet diſtance; but we thought them equal at the diſtance of 40 and 18. The reſult was the ſame in many trials made by different perſons, and in different circumſtances. This leads us to ſuſpect ſome miſtake in Mr. Lambert's principle of calculation; and we think him miſtaken in the manner of eſtimating the intenſity of the reflected ſounds. He conceives the proportion of intenſity of the ſimple voice and of the trumpet to be the ſame with that of the ſurface of the mouth-piece to the ſurface of the ſonorous hemiſphere, which he has ſo ingeniouſly ſubſtituted for the trumpet. But this ſeems to ſuppoſe, that the whole ſurface, generated by the revolution of the quadrantal arch TEG round the axis CG (fig. 4.), is equally ſonorous. We are aſſured that it is not: For even if we ſhould ſuppoſe that each of the points Q, R, and S (fig. 3.), are equally ſonorous with the point P, theſe points of reflection do not ſtand ſo denſe on the ſurface of the ſphere as on the ſurface of the mouth-piece. Suppoſe them arranged at equal diſtances all over the mouth-piece, they will be at equal diſtances alſo on the ſphere, only in the direction of the arches of great circles which paſs through the centre of the mouth-piece. But in the direction perpendicular to this, in the circumference of ſmall circles, having the centre of the mouth-piece for their pole, they muſt be rarer in the proportion of the ſine of their diſtance from this pole. This is certainly the caſe with reſpect to all ſuch ſounds as have been reflected in the planes which paſs through the axis of the trumpet; and we do not ſee (for we have not examined this point) that any compenſation is made by the reflection which is not in planes

planes paſſing through the axis. We therefore imagine, that the trumpet does not increaſe the ſound in the proportion of $g E^2$ to $g T^2$ (fig. 5.), but in that of $\frac{g E^2}{GE}$ to $\frac{g T^2}{CT}$.

Mr Lambert ſeems aware of ſome error in his calculation, and propoſes another, which leads nearly to this concluſion, but founded on a principle which we do not think in the leaſt applicable to the caſe of ſounds.

TRUMPET, *Marine*, is a muſical inſtrument conſiſting of three tables, which form its triangular body. It has a very long neck with one ſingle ſtring, very thick, mounted on a bridge, which is firm on one ſide, but tremulous on the other. It is ſtruck by a bow with one hand, and with the other the ſtring is preſſed or ſtopped on the neck by the thumb.

It is the trembling of the bridge, when ſtruck, that makes it imitate the ſound of a trumpet, which it does to that perfection, that it is ſcarcely poſſible to diſtinguiſh the one from the other. And this is what has given it the denomination of trumpet-marine, though, in propriety, it be a kind of monochord. Of the ſix diviſions marked on the neck of the inſtrument, the firſt makes a fifth with the open chord, the ſecond an octave, and ſo on for the reſt, correſponding with the intervals of the military trumpet.

TRUMPET-Flower. See BIGNONIA, BOTANY *Index*.

TRUMPETER. See PSOPHIA, ORNITHOLOGY *Index*.

TRUNCATED, in general, is an appellation given to ſuch things as have, or ſeem to have, their points cut off: thus, we ſay, a truncated cone, pyramid, leaf, &c.

TRUNCHEON, a ſhort ſtaff or baton uſed by kings, generals, and great officers, as a mark of their command.

TRUNDLE, a ſort of carriage with low wheels, whereon heavy and cumberſome burdens are drawn.

TRUNK, among botaniſts, that part of the herb which ariſes immediately from the root, and is terminated by fructification; the leaves, buds, and auxiliary parts of the herb not entering in its deſcription.

TRUNNIONS, or TRUNIONS, of a piece of ordnance, are thoſe knobs or bunches of metal which bear her up on the cheeks of the carriage.

TRUSS, a bundle, or certain quantity of hay, ſtraw, &c. A truſs of hay contains 56 pounds, or half an hundred weight: 36 truſſes make a load.

TRUSS is alſo uſed for a ſort of bandage or ligature made of ſteel, or the like matter, wherewith to keep up the parts in thoſe who have hernias or ruptures.

TRUSS, in a ſhip, a machine employed to pull a yard home to its reſpective maſt, and retain it firmly in that poſition.

TRUSTEE, one who has an eſtate, or money, put or truſted in his hands for the uſe of another.

TRUTH, a term uſed in oppoſition to falſehood, and applied to propoſitions which anſwer or accord to the nature and reality of the thing whereof ſomething is affirmed or denied.

TRYPHIODORUS, an ancient Greek poet, who lived ſome time between the reigns of Severus and Anaſtaſius. His writings were very numerous; yet none of them have come down to us, except an epic poem, on which Mr Addiſon has made ſome entertaining remarks in the Spectator, N° 63.

The firſt edition of this extraordinary work was publiſhed by Aldus at Venice, with Quintus Calaber's Paralipomena, and Coluthus's poem on the rape of Helen. It has been ſince reprinted at ſeveral places, particularly at Francfort in 1580 by Friſchlinus; who not only corrected many corrupt paſſages, but added two Latin verſions, one in verſe and the other in proſe. That in verſe was reprinted in 1742, with the Greek, at Oxford, in 8vo, with an Engliſh tranſlation in verſe, and Notes, by Mr Merrick.

TUAM, a town of Ireland, in the province of Connaught, and county of Galway, with an archbiſhop's ſee. It was once a famous city, though now it is reduced to a village; but it ſtill retains the title of a city, as being an archiepiſcopal ſee. W. Long. 8. 46. N. Lat. 53. 33.

TUB, in commerce, denotes an indetermined quantity or meaſure: thus, a tub of tea contains about 60 pounds; and a tub of camphor from 56 to 86 pounds.

TUBE, in general, a pipe, conduit, or canal; a cylinder, hollow within-ſide, either of lead, iron, glaſs, wood, or other matter, for the air or ſome other matter to have a free conveyance through it.

Auricular TUBE, or inſtrument to facilitate hearing. See *Articulate TRUMPET*.

TUBERCLES, among phyſicians, denote little tumors which ſuppurate and diſcharge pus; and are often found in the lungs, eſpecially of conſumptive perſons.

TUCUMAN, a province of Paraguay, in South America, bounded on the north by the provinces of Los-Chicas and Choco; on the eaſt by Choco and Rio-de-la-Plata, on the ſouth by the country of Chicuitos and Pampes, and on the weſt by the biſhopric of St Jago. The air is hot, and the ſoil ſandy: however, ſome places are fruitful enough. The Spaniards poſſeſs a great part of this country.

TUFA, a ſtone conſiſting of volcanic aſhes concreted together with various other ſpecies of ſtone. It is of various colours, blackiſh gray, bluiſh gray, and yellow; every colour having a different mixture and ſolidity: but all of them have the bad quality of mouldering down on long expoſure to the weather; notwithſtanding which, they have been uſed in buildings both ancient and modern. The yellow kind reſiſts the air leſs than any other.

TULIPA, TULIP; a genus of plants belonging to the claſs of hexandria; and in the natural ſyſtem ranging under the 10th order, *Coronariæ*. See BOTANY *Index*; and for the culture of the tulip, ſee GARDENING.

TULIP-Tree. See LIRIODENDRON, BOTANY *Index*.

TULL, JETHRO, an Oxfordſhire gentleman who farmed his own land, and introduced a new method of culture, to raiſe repeated crops of wheat from the ſame land without the neceſſity of manure: the principles of which he publiſhed about 30 years ſince, in a Treatiſe on Horſe-hoeing Huſbandry.

TUMBRELL, TUMBRELLUM, or *Turbichetum*, is an engine of puniſhment, formerly employed for the correction of ſcolds and unquiet women.

TUMEFACTION, the act of ſwelling or riſing into a tumor.

TUMOR, in *Medicine* and *Surgery*, a preternatural riſing or eminence in any part of the body.

Tumors, in *Farriery*. See Farriery *Index*.

TUN, a large veſſel or caſk, of an oblong form, biggeſt in the middle, and diminiſhing towards its two ends, girt about with hoops, and uſed for ſtowing ſeveral kinds of merchandiſe for convenience of carriage; as brandy, oil, ſugar, ſkins, hats, &c.

Tun is alſo the name of a meaſure. A tun of wine is four hogſheads; of timber, a ſquare of 40 ſolid feet; and of coals, 20 cwt.

Tun is alſo a certain weight whereby the burden of ſhips, &c. is eſtimated.

TUNBRIDGE, a town of Kent in England, ſituated on a branch of the river Medway, over which there is a bridge. It is a large well built place, noted for the mineral waters four or five miles ſouth of the town. E. Long. 0. 20. N. Lat. 51. 14.

TUNE. See Music and Tone.

TUNGSTEN, one of the metals. See Chemistry and Mineralogy *Index*.

TUNICA, a kind of waiſtcoat or under garment, in uſe among the Romans. They wore it within doors by itſelf, and abroad under the gown. The common people could not afford the toga, and ſo went in their tunics; whence Horace calls them *populus tunicatus*.

Tunica, in *Anatomy*, is applied to the membranes which inveſt the veſſels, and divers others of the leſs ſolid parts of the body; thus the inteſtines are formed of five tunics or coats.

TUNIS, a large and celebrated town of Barbary, in Africa, and capital of a kingdom of the ſame name. It is ſeated on the point of the gulf of Goletta, about eight miles from the place where the city of Carthage ſtood. It is in the form of a long ſquare, and is about four miles in circumference, with ten large ſtreets, five gates, and 35 moſques. The houſes are all built with ſtone, though but one ſtory high; but the walls are very lofty, and flanked with ſeveral ſtrong towers. It has neither ditches nor baſtions, but a good citadel, built on an eminence on the weſt ſide of the city. It is ſaid to contain 300,000 inhabitants, of whom 30,000 are Jews. The divan, or council of ſtate, aſſembles in an old palace; and the dey is the chief of the republic, who reſides there. The harbour of Tunis has a very narrow entrance, through a ſmall canal. In the city they have no water but what is kept in ciſterns, except one well kept for the baſhaw's uſe. It is a place of great trade, and is 10 miles from the ſea. E. Long. 10. 16. N. Lat. 36. 42.

See *Obſerv. on the City of Tunis by Mr Stanley, in the Edin. Mag.* vol. iv. p. 28.

Tunis, a country of Africa, bounded on the north and eaſt by the Mediterranean ſea and the kingdom of Tripoli, on the ſouth by ſeveral tribes of the Arabs, and on the weſt by the kingdom of Algiers and the country of Eſab; being 300 miles in length from eaſt to weſt, and 250 in breadth from north to ſouth. This country was formerly a monarchy; but a difference ariſing between a king and his ſon, one of whom was for the protection of the Chriſtians, and the other for that of the Turks, in 1574 the inhabitants ſhook off the yoke of both. From this time it became a republic under the protection of the Turks, and pays a certain tribute to the baſhaw who reſides at Tunis. The air in general is healthy; but the ſoil in the eaſtern parts is indifferent for want of water. Towards the middle the mountains and valleys abound in fruits; but the weſtern part is the moſt fertile, becauſe it is watered with rivers. The environs of Tunis are very dry, upon which account corn is generally dear. The inroads of the Arabs oblige the inhabitants to ſow their barley and rye in the ſuburbs, and to incloſe their gardens with walls. However, there are plenty of citrons, lemons, oranges, dates, grapes, and other fruits. There are alſo olive trees, roſes, and odoriferous plants. In the woods and mountains there are lions, wild beeves, oſtriches, monkeys, cameleons, roebucks, hares, pheaſants, partridges, and other ſorts of birds and beaſts. The moſt remarkable rivers are the Guadilcarbar, Magrida, Magerada, and Caps. The form of government is ariſtocratic; that is, by a council, whoſe preſident is the dey, not unlike the doge of Venice. The members of the divan or council are choſen by the dey, and he in his turn is elected by the divan; which is compoſed of ſoldiers, who have more than once taken off the dey's head. The baſhaw is a Turk, reſiding at Tunis; whoſe buſineſs is to receive the tribute, and protect the republic: the common revenues are only 400,000 crowns a-year, becauſe the people are very poor; nor can they ſend above 40,000 men into the field; nor more than 12 men of war of the line to ſea, even upon the moſt extraordinary occaſions. There are generally about 12,000 Chriſtian ſlaves in this country; and the inhabitants carry on a great trade in linen and woollen cloth. In the city of Tunis alone there are above 3000 clothiers and weavers. They alſo have a trade in horſes, olives, oil, ſoap, oſtriches eggs and feathers. The Mahometans of this city have nine colleges for ſtudents, and 86 petty ſchools. The principal religion is Mahometaniſm; but the inhabitants conſiſt of Moors, Turks, Arabs, Jews, and Chriſtian ſlaves. However the Turks, though feweſt, in number, domineer over the Moors, and treat them little better than ſlaves.

TUNKERS, a religious ſect of Baptiſts in Pennſylvania, ſo called from the word *tunker*, to put a morſel in ſauce. They are alſo called *tumblers*, becauſe in performing baptiſm they plunge the perſon into the water with the head firſt. As the Germans ſound the letters *t* and *b* like *d* and *p*, the words *tunkers* and *tumblers*, have been ſometimes written *dunkers* and *dumplers*. Their church government and diſcipline are the ſame with thoſe of the Engliſh Baptiſts, except that every brother is allowed to ſpeak in the congregation, and the beſt ſpeaker is uſually ordained to be their miniſter. They are a harmleſs, well-meaning people.

TUNNAGE. See Tonnage.

TUNNY. See Scomber, Ichthyology *Index*.

TUNNY-Fishing. See Fishery.

TURBAN, the head-dreſs of moſt of the eaſtern nations. It conſiſts of two parts, a cap and ſaſh of fine linen or taffety, artfully wound in divers plates about the cap. The cap has no brim, is pretty flat, though roundiſh at top, and quilted with cotton; but does not cover the ears. There is a good deal of art in giving the turban a fine air; and the making of them is a particular trade. The ſaſh of the Turk's turban is white linen; that of the Perſians red woollen. Theſe are the diſtinguiſhing marks of their different religions. Sophi king of Perſia, being of the ſect of Ali, was the firſt who aſſumed the

the red colour, to diſtinguiſh himſelf from the Turks, who are of the ſect of Omar, and whom the Perſians eſteem heretics.

TURBINATED, is a term applied by naturaliſts to ſhells which are ſpiral, or wreathed conically from a larger baſis to a kind of apex.

TURBITH or Turpeth mineral. See Mercury, N° 1720 and 1728 Chemistry.

TURBO, the Wreath, a genus of ſhell-fiſh. See Conchology *Index*.

TURBOT. See Pleuronectes, Ichthyology *Index*.

TURCÆ or Turci, (Mela); ſuppoſed to be the *Tuſci* of Ptolemy; whom he places between Caucaſus and the Montes Ceraunii. The name is ſaid to denote, "to deſolate, or lay waſte." Herodotus places them among the wild or barbarous nations of the north. There is a very rapid river called *Turk*, running into the Caſpian ſea, from which ſome ſuppoſe the Turks to take their name. They made no figure in the world till towards the 7th century; about the beginning of which they ſallied forth from the Portæ Caſpiæ, laid waſte Perſia, and joined the Romans againſt Choſroes king of Perſia. In 1042 they ſubdued the Perſians, in whoſe pay they ſerved, and from whom they derived the Mahometan religion; and afterwards pouring forth, overran Syria, Cappadocia, and the other countries of the Hither Aſia, under diſtinct heads or princes, whom Ottoman ſubduing, united the whole power in himſelf, which to this day continues in his family, and who fixed his ſeat of empire at Pruſa in Bithynia. His ſucceſſors ſubdued all Greece, and at length took Conſtantinople in 1453; which put a period to the Roman empire in the Eaſt, under Conſtantine the laſt emperor. It is a ſtanding tradition or prophecy among the Turks, that their empire will at length be overturned by the Franks or Chriſtians; which ſeems now to be drawing on apace towards accompliſhment.

TURCOISE. See Turquoise.

TURCOMANIA, a province of Aſiatic Turkey, anſwering to the ancient kingdom of Armenia.

TURDUS, the Thrush; a genus of birds belonging to the order of *Paſſeres*. See Ornithology *Index*.

TURENNE, Viscount. See Tour.

TURF, *peat*, a blackiſh earth uſed in ſeveral parts of the world as fuel. Turf, as diſtinguiſhed from peat, conſiſts of mould interwoven with the roots of vegetables.

TURGESCENCE, among phyſicans, denotes a ſwelling or growing bloated.

TURGOT, Anne Robert James, a celebrated French financier, was born at Paris in 1727, of a very ancient Norman family. His father was a long time provoſt of the corporation of merchants; during which he was the object of general admiration, on account of his prudent adminiſtration. M. Turgot was the youngeſt of three brothers, and was deſtined for the church. He had ſcarcely attained the age at which reflection commences, when he reſolved to ſacrifice all temporal advantages to liberty and conſcience, and to purſue his eccleſiaſtical ſtudies without declaring his repugnance to their propoſed object. At the age of 23 years he took his degree, and was elected prior of the Sorbonne.

The time when it was neceſſary for him to declare that he would not be an eccleſiaſtic was now arrived. He announced this reſolution to his father by letter, ſhowing the motives which induced him to decline the clerical order. His father conſented, and he was appointed maſter of requeſts. M. Turgot prepared himſelf for this office by particular application to thoſe parts of ſcience which are moſt connected with its functions and duties, viz. natural philoſophy, agriculture, manufactures, commerce, &c. About this period he wrote ſome articles for the *Encyclopédie*, of which the principal are Etymology, Exiſtence, Expanſibility, Fair, and Foundation. He had prepared ſeveral others, but the perſecution againſt the *Encyclopédie* induced him to decline farther contributions.

In 1761 M. Turgot was appointed intendant of Limoges, when he gave activity to the ſociety of agriculture; opened a mode of public inſtruction for female profeſſors of midwifery; procured for the people the attendance of able phyſicians during the raging of epidemic diſeaſes; eſtabliſhed houſes of induſtry, ſupported by charity (the only ſpecies of alms-giving which does not encourage idleneſs): introduced the cultivation of potatoes into his province, &c. &c. While M. Turgot proceeded with unremitting activity and zeal, in promoting the good of the people over whom he was placed, he meditated projects of a more extenſive nature, ſuch as an equal diſtribution of the taxes, the conſtruction of the roads, the regulation of the militia, the prevention of a ſcarcity of proviſion, and the protection of commerce.

At the death of Louis XV. the public voice called M. Turgot to the firſt offices of government, as a man who united the experience reſulting from habits of buſineſs to all the improvement which ſtudy can procure. After being at the head of the marine department only a ſhort time, he was, Auguſt 24. 1774, appointed comptroller general of the finances. During his diſcharge of this important office, the operations he carried on are aſtoniſhing. He ſuppreſſed 23 kinds of duties on neceſſary occupations, uſeful contracts, or merited compenſations. He aboliſhed the corvée, or the labour required from the public for the highways, ſaving the nation thirty millions of livres annually.—He ſet aſide another kind of corvée, which reſpected the carriage of military ſtores and baggage.—He abated the rigour in the adminiſtration of indirect impoſitions, to the great profit of the contributors, the king, and the financiers; beſide many other eſſential improvements in political economy.

At length, however, by the artifices of the courtiers, he was deprived of his offices; and in retirement he devoted himſelf to the ſciences and the belles lettres, which he had cultivated in his youth. Natural philoſophy and chemiſtry were his favourite purſuits; ſometimes he indulged in poetry. He compoſed, it is ſaid, only one Latin verſe, intended for a picture of Dr Franklin.

Eripuit cœlo fulmen, mox ſceptra tyrannis."

He died in 1781.

TURIN, an ancient and populous city of Italy, and capital of Piedmont, where the ſovereign reſides, with an archbiſhop's ſee, a ſtrong citadel, and an univerſity. It is ſeated on a vaſt plain, at the confluence of the rivers Doria and Po. But the air is unhealthy in the autumn

Turin, Turkey.

tumn and winter on account of the thick fogs. One half of this place is lately built; and the ſtreets are ſtraight and clean, being waſhed by an aqueduct. It contains many elegant buildings. When the plague reigned at Marſeilles in 1720, a great number of artificers withdrew to Turin; inſomuch that there are now above 87,000 inhabitants, and 48 churches and convents. Turin is very well fortified, and extremely ſtrong; as the French found by experience in 1706, who then beſieged it a long while to no purpoſe. The citadel, which is flanked with five baſtions, is without doubt a maſterpiece of architecture. There are fine walks on the ramparts, and fine gardens on the ſide of the river Po; and the houſe commonly called *La Charité* is remarkable, as there is room for 3000 poor people. The college of the academy is very large and well built, and has a great number of ancient inſcriptions. In the royal library are 19,000 manuſcripts, beſides 30,000 printed books. In December 1798, it was taken poſſeſſion of by the French, who in June following were driven out of it by the Auſtrians. But with the reſt of Italy it is now under the dominion of the French. It is charmingly ſeated at the foot of a mountain, 62 miles north-eaſt of Genoa, 72 ſouth-weſt of Milan, and 280 north-weſt of Rome. E. Long. 7. 45. N. Lat. 44. 50.

1 Situation and extent.

TURKEY, an extenſive empire, ſituated partly in Europe, and partly in Aſia. It is bounded on the north by the empire of Ruſſia, Hungary, and the Black ſea; on the weſt by the gulf of Venice and the Mediterranean; on the ſouth by the Mediterranean and Arabia; and on the eaſt by Perſia. In its preſent ſtate, we may compute it as extending from the river Unna, in eaſt longitude about 17°, to the mountains which ſeparate it from Perſia, in about 50° of eaſt longitude from Greenwich, or about 33° from weſt to eaſt; while from the moſt ſoutherly point, a little above Baſſora, in north latitude 31°, to the confines of European Ruſſia, in north latitude 47°, it occupies a range of 16° of latitude. In Britiſh miles its extent is eſtimated at 1750 in length, by a medial breadth of about 1000, and its area at 652,960 ſquare miles.

2 Diviſions.

Turkey is naturally divided into European and Aſiatic, ſeparated from each other by the Black ſea, the Archipelago, and the ſtraits by which theſe are connected. European Turkey is ſubdivided into 11 provinces, viz. Moldavia, Beſſarabia, Wallachia, Bosnia, Servia (partially), Bulgaria, Romelia (including *Macedonia* and *Thrace*), Dalmatia, Albania (including *Epirus*), Croatia (partially), and the Morea, or ancient Greece; while Aſiatic Turkey is ſubdivided into ſeven provinces, viz. Natolia (*Aſia Minor*), Diarbec (*Meſopotamia*), Syria (including *Judæa*), Georgia (*Iberia*), Turcomania (*Armenia*), Irac-Arabia, and Kurdistan (*Aſſyria*). See each of theſe articles in the general alphabet.

3 Iſlands.

The iſlands belonging to Turkey are extremely numerous; compriſing thoſe of the Archipelago, or the Grecian iſlands, and ſeveral in the Levant. The moſt important are Lemnos, Lesbos or *Mytelene*, Scio, Samos, Cos, Rhodes, Cyprus, Candia, Paros, Delos, Naxia, Sanctorini. Patmos, Negropont, Andro *, Colteri or *Salamis* *, Egina, Zante *, Cephalonia, Leucadia, Corfu, and Cerigo or *Cytherea*, which ſee under their proper heads.

* See *Venice*.

4 Face of the country.

Both European and Aſiatic Turkey abound in mountainous tracts, interſperſed with numerous plains and valleys, and here and there a deſert of conſiderable extent. The plains are watered by numerous large rivers, and, in the Aſiatic part, conſiſt chiefly of paſture grounds.

5 Mountains.

Among the mountains of European Turkey may be noticed the Carpathian chain, which divides it from the Auſtrian territories; the celebrated mountains of Hæmus; the Acroceraulian mountains; and the claſſical hills of Pindus, Oſſa, Pelios, and Athos. The moſt important mountains of Aſiatic Turkey are, Mount Caucaſus, dividing it from Ruſſia; Mount Taurus, now called Thuron; Olympus; Ida; the mountains of Elivend, and perhaps Mount Ararat, the reſting-place of the Ark, dividing it from Perſia; and Mount Lebanon, celebrated in ſcripture for its cedars.

6 Rivers.

The principal river of European Turkey is the Danube, with its tributary ſtreams, the Save, the Morava, the Boſna, and the Pruth; but we may alſo notice the Mariſſa or Hebrus, and the Vardan or Axius. In Aſiatic Turkey are ſeen the Kiſil-Irmak or Halys, the Saccaria, the Sarabat or Hermus, the Minder or Meander, the Araxes, the Orontes, the Jordan, and the Euphrates.

7 Lakes.

The lakes of European Turkey are of little importance, and in the Aſiatic part there are only three that merit notice. Theſe are the Dead ſea and the ſea of Galilee in Paleſtine, and the Van in Armenia.

8 Climate and ſeaſons.

The climate in the greater part of the Turkiſh empire is delightful, and the ſeaſons mild and genial. The heats of the ſummer, except in the deſerts of Syria, and on the ſhores of the Black ſea, are tempered by the keen winds that blow from the higher regions, and the winter is in general extremely mild. The unhealthineſs of the large towns on the coaſt of Aſiatic Turkey, is owing much more to the indolent and dirty habits of the people, than to any inſalubrity of the climate.

9 Natural hiſtory.

Turkey affords a moſt ample field to the naturaliſt, whether his taſte lead him to explore the animal, the vegetable, or the mineral kingdom. In the firſt of theſe he will find the lion, a variety of the tiger, the hyena, the jackal, the ibex, the goat and cat of Angora, and many other quadrupeds common in Europe. Among the birds, one of the moſt numerous and moſt uſeful is the ſtork; partridges of a large ſize, quails, woodcocks, cranes, and ſeveral birds of prey, are alſo very common. The Black ſea and the Archipelago abound with excellent fiſh, and contain great variety of curious molluſca, and other marine animals. Among the inſects, that deſtructive animal the locuſt is a frequent viſitant; and Sonnini particulariſes the tarantula, and a monſtrous ſpecies of ſpider, which he calls *galeode araneoide*, or the ſcorpion ſpider. Of the domeſtic animals, the Turks abound in excellent horſes, aſſes of a large ſize, and that moſt uſeful beaſt of burden, the camel.

To enumerate the vegetable productions of Turkey, would far exceed our ſcanty limits. The foreſts of European Turkey, though far leſs extenſive than in ancient times, furniſh abundance of the fineſt timber, eſpecially oak, cedar, larch, walnut, cheſnut, and beech, while the olive, the date, the almond, the peach, the mulberry, the cherry, the lemon, and the orange, are the natural productions of Aſiatic Turkey. Many of the moſt valuable drugs employed in medicine, are alſo the produce of this empire, eſpecially opium, rhubarb, myrrh, aſafœtida and other fetid gums, ſcammony, ſenna, galls, and coloquintida.

Both gold and ſilver mines are found in Turkey, but from the indolence of the natives they are ſcarcely ever worked. Many of the iſlands abound in mineral treaſures, eſpecially Cyprus, where are found mines of gold, copper, vitriol, and iron; and where rock cryſtal, jaſper, and ſeveral precious ſtones are occaſionally procured. The chief mineral production of Turkey, however, is its marble, of which it furniſhes ſeveral of the moſt rare and beautiful varieties. That from the Grecian iſland Paros, is proverbially excellent.

10
Outline of the Turkiſh hiſtory.

The people whom we now call Turks, and who form the great maſs of population of the Turkiſh empire, are generally believed to be the deſcendants of the ancient Scythians. Theſe are ſuppoſed to have migrated from the Altai mountains in Tartary, about the middle of the ſixth century, and to have gradually diffuſed themſelves towards the weſt, till they reached the lake Mæotis, the modern ſea of Azof, near which they ſettled in Armenia Minor or Turcomania. At this time the Roman empire in the eaſt was ſufficiently ſtrong to prevent the invaders from extending beyond the river Oxus, on the banks of which they eſtabliſhed themſelves, and ſoon became a formidable foe to the emperors of Conſtantinople.

11
Foundation of the Ottoman empire.
A. D. 1300.

12
Eſtabliſhment of the Janizaries, 1362.

There is little certain or intereſting in the hiſtory of theſe barbarians till the reign of the caliph Othman, or Oſman, who in the end of the 13th century eſtabliſhed what from him has been called the Ottoman empire. He firſt took the title of ſultan, and fixed the ſeat of his government at Pruſa, the capital of Bithynia. His ſucceſſor Orkan was a reſtleſs, ambitious, and cruel prince, who greatly extended the limits of the empire, took poſſeſſion of Gallipoli, and penetrated into Thrace. Amurath the grandſon of Oſman, in 1362, eſtabliſhed the famous military bands called *janizaries*, which ſtill form the chief engines and chief moderators of Turkiſh deſpotiſm. Theſe were firſt compoſed of young Chriſtian ſlaves that had been taken in war, and educated in the Mohammedan religion. They were inured to obedience by ſevere diſcipline, and trained to warlike exerciſe; and as every ſentiment which enthuſiaſm can inſpire, and every mark of honour which the favour of the prince could confer, were employed to animate them with martial ardour, and excite in them a ſenſe of their own importance, theſe janizaries, (or new ſoldiers) ſoon became the chief ſtrength and pride of the Ottoman arms. On the aſſaſſination of Amurath in 1389, he was ſucceeded by his ſon Bajazet, ſurnamed Ilderim, or the Thunderbolt, whoſe reign forms one of the moſt ſplendid epochs in the Turkiſh hiſtory.

13
Reign of Bajazet.
An. 1389.

Early in this reign, viz. in 1396, the Hungarians were defeated at Nicopoli in Bulgaria, and in 1402, was fought the famous battle between Bajazet and Timur or Tamerlane, the chief of the Moguls, between Ceſarea and Aneyra, which ended in the captivity of Bajazet, and the temporary humiliation of the Turks. See MOGULS, N° 19 and 20.

On the death of Bajazet, his ſon Mouſa became ſultan, and in 1412 defeated the emperor Sigiſmund with great ſlaughter. Mouſa was ſucceeded by his brother Mohammed I. by whom he had been aſſaſſinated. The reign of Amurath II. ſucceſſor of Mohammed, contributed greatly to increaſe the ſplendour of the Turkiſh empire. In this reign Conſtantinople was attacked, but for the preſent eſcaped pillage. Amurath was ſucceſsfully oppoſed in his hoſtilities againſt the Chriſtian princes, by the Albanian chief George Caſtriota, whom the Turks call Scanderbeg *.

* See *Scanderbeg.*

14
Taking of Conſtantinople,
An. 1453.

Amurath was ſucceeded by Mohammed II. and ſoon after his acceſſion, viz. in 1453, the city of Conſtantinople was taken by the Turks, and has ever ſince remained the capital of their empire. The events of which we have thus drawn the faint outline, are related at ſome length in the article CONSTANTINOPOLITAN HISTORY, N° 111.—168.

15
Other ſucceſſes of Mohammed II.

Three years after the taking of Conſtantinople, Mohammed laid ſiege to Belgrade, from which, after an obſtinate reſiſtance, he was at length repulſed with conſiderable loſs. Abandoning his attempt on Hungary, the ſultan made preparations for an expedition into Greece, where the princes Thomas and Demetrius, brothers of the emperor, ſtill continued to maintain their authority. Alarmed at the progreſs of the Turkiſh arms, theſe princes reſolved on retiring into Italy, on which the peninſula was ſeized by the Albanians. This tribe ſent a deputation to Mohammed, offering to give up to him the Grecian cities and fortreſſes, provided they ſhould be allowed to keep the open country; but this offer was rejected by the ſultan, who under the appearance of aſſiſting the Greeks, entered the country with a formidable army, defeated the Albanians, took ſeveral cities, and carried off great numbers of the inhabitants.

16
Bajazet II.
An. 1481.

An. 1512.

Mohammed was ſucceeded by his ſecond ſon Bajazet II. in 1481, preferred by the janizaries to his elder brother Zizan, who fled for protection to Pope Alexander VI. by whom he is ſaid to have been poiſoned, at the inſtigation of Bajazet, and for the reward of 300,000 ducats. Selim, his youngeſt ſon and ſucceſſor, was a ſucceſsful prince. He conquered Egypt, Aleppo, Antioch, Tripoli, Damaſcus, and Gaza, and defeated the Perſians. Solyman, ſurnamed the Magnificent, one of the moſt accompliſhed, enterpriſing, and warlike, of the Turkiſh princes, aſcended the Ottoman throne in conſequence of the death of Selim.

17
Solyman I.
An. 1520.

Having quelled ſome inſurrections in Aſia, he commenced hoſtilities againſt the European princes, and entering Hungary, made himſelf maſter of Belgrade, then reckoned the chief barrier of that kingdom againſt the Turkiſh power. He next turned his victorious arms againſt the iſland of Rhodes, then the ſeat of the knights of St John of Jeruſalem. After incredible efforts of courage and military conduct, the knights obtained an honourable capitulation, and retired to the ſmall iſland of Malta, where they fixed their reſidence. See MALTA. He afterwards annexed Hungary to the Ottoman empire. His dominions extended from Algiers to the river Euphrates, and from the farther end of the Black ſea to the extremity of Greece and Epirus. During the ſiege of Sigeth, a city of Hungary, before which the Turks loſt above 30,000 men, Solyman expired in the 74th year of his age, and 41ſt of his reign.

18
Selim II.
An. 1566.

His ſon and ſucceſſor, Selim II. beſieged and took Cyprus; but in the famous ſea fight at Lepanto, in 1571, the Turkiſh fleet was utterly deſtroyed by Don John of Auſtria. He afterwards inveſted and took Tunis by ſtorm, putting the garriſon to the ſword.

19
Amurath III.
An. 1575.

On his death, Amurath III. aſcended the Ottoman throne, and extended his dominions on both ſides by the addition of Raab in Hungary, and Tigris in Perſia. His ſon, Mohammed III. has no claim to notice except

20
Mohammed III.

21
Achmet I.
An. 1603.

except on account of his barbarity. He began his reign by ſtrangling 19 of his brothers, and ordering 12 of his father's wives, whom he ſuſpected to be pregnant, to be drowned. This monſter of cruelty had, however, a ſucceſsful reign of nine years duration. During the government of his ſon, Achmet I. the affairs of Turkey underwent a material change for the worſe *. On his death, the janizaries and the divan elected his brother Muſtapha, whom in two months they declared incapable of reigning, and threw him into priſon; after this they proclaimed his young nephew, Oſman, the ſon of Achmet, emperor. This prince formed a deſign of curbing the power of the janizaries, for which he was depoſed and murdered; and Muſtapha was again called from his priſon to the imperial throne, but was ſoon after ſtrangled.

* See *Achmet I.*

22
Amurath IV.
An. 1622.

Under Amurath, or Morad IV. ſurnamed Gaſi, the Intrepid, every thing again aſſumed a new appearance. He was ſucceſsful in his wars, and took Bagdat from the Perſians. A debauch of wine put an end to his life, and diſhonoured his memory. His ſon Ibrahim, who ſucceeded him, had every vice; he was a weak prince, and wholly deſtitute of courage. He was ſtrangled by four mutes.

23
Mohammed IV.
An. 1649.

An. 1687.

24
Muſtapha II.
An. 1695.

After a long interval of inactivity, the Turks again became formidable to Europe, under Mohammed IV. who ſucceeded him. His grand viſier Kupuli, who at once directed the councils and conducted the armies of the Porte, took Candia from the Venetians. After carrying on many wars againſt the Germans, the Poles, the Ruſſians, and other European powers, he was compelled to reſign the turban to Solyman II. in 1687, a prince happy in his domeſtic government, but unſucceſsful in his wars. His brother, Achmet II. was likewiſe unfortunate in his wars. In his reign the Turks were driven out of Hungary and Tranſylvania †. The acceſſion of his nephew, Muſtapha II. to the Ottoman throne, gave a new turn to the affairs of the Porte. Poſſeſſed of more vigour than his predeceſſor, he reſolved to command his troops in perſon. He accordingly took the field, paſſed the Danube, ſtormed Lippa, ſeized Itul, and falling ſuddenly on a body of Imperialiſts, under Veterani, he killed that officer, diſperſed his forces, and cloſed with ſucceſs the campaign. He was afterwards defeated by Prince Eugene in an uncommonly bloody battle at Zenta, a ſmall village on the weſtern bank of the Thuyſe, in the kingdom of Hungary. About 20,000 Turks were left dead on the field, and 10,000 were drowned in the river, endeavouring to avoid the fury of the ſword. The magnificent pavilion of the ſultan, and all the ſtores, fell into the hands of Prince Eugene, and ſoon after this misfortune the haughty Muſtapha was dethroned.

† See *Achmet II.*

25
Achmet III.

His brother and ſucceſſor, Achmet III. gave an aſylum to Charles XII. king of Sweden, at Bender, a Turkiſh town in Moldavia, after his defeat at the battle of Pultava. (See RUSSIA, N° 118. and SWEDEN, N° 140.). Being unſucceſsful in his war againſt Kouli Khan and the Perſians (ſee PERSIA), he was depoſed, and ſucceeded by Mohammed V.

26
Muſtapha III.
An. 1754.

From the depoſition of Achmet III. till the acceſſion of Muſtapha III. in 1754, nothing of importance occurs in the hiſtory of the Turkiſh empire. During the reign of this latter ſultan was begun and terminated that deſtructive war with Ruſſia, of which the principal events have been enumerated in the article RUSSIA, N° 143 and 144.

27
Appearance of a new prophet in Aſia.

In this reign an extraordinary alarm was excited in Turkey by the ſudden appearance of a new prophet in Upper Aſia. This man, whoſe name was *Shiek Manſour*, pretended that he was predoomed by the eternal immutable decrees of heaven to fill up the meaſure of divine revelation to mankind; and that, as he was to be the laſt, ſo he was the greateſt of the prophets. The ſcene of his miniſtry was in the wide and deſolate regions on the borders of the Caſpian ſea; and though the firſt rumour of his proceedings repreſented him as at the head of a multitude of armed enthuſiaſts, ready to overturn the eſtabliſhed government, and the religion of Mohammed, it was ſoon diſcovered that all the military fury of his zeal was directed againſt the Chriſtians.

28
A rebellion in Egypt.

About the ſame time a formidable rebellion broke out in Egypt, which, though it has never properly formed a part of the Turkiſh empire, may be conſidered as tributary to the Turks, and as conſtituting the granary of that empire. This rebellion, which has been ſufficiently noticed under the article EGYPT, N° 125, was ſuppreſſed chiefly by the wiſe conduct and intrepid bravery of Hoſſan Bey, the captain pacha, who at the age of 70, fought with all the ardour of youth, and all the ſkill of the moſt conſummate general. That veteran, however, was recalled before he was able to carry all his patriotic deſigns into execution, that he might aid the divan with his council, in the critical ſituation into which the empire was brought by the arrogant claims of the court of Ruſſia. The reſult of the deliberations was a precipitate declaration of war againſt that court, contrary to the better judgement of the old pacha. The war commenced in autumn 1787, and the hordes of Tartars which were firſt brought into the field, headed by the new prophet, were everywhere defeated by the ſuperior diſcipline of the Ruſſian troops commanded by Prince Potemkin. Some enterpriſes which were undertaken by the Turks againſt the iſland of Taman and the Krimea were attended with as little ſucceſs as the attempts of the Tartars; while the emperor Joſeph declared to the Porte, that he would aſſiſt his ally the empreſs of Ruſſia with an army of 80,000 men. Four Auſtrian armies were accordingly aſſembled; one at Carlſtadt in Croatia, under the command of General de Vins; another at Peterwaradin in Hungary, commanded by General Langlois; a third on the borders of Lithuania, under General Febris; and the fourth in the Buccowine, under the orders of the prince of Saxe-Cobourg. Two other generals, 10 lieutenant-generals, and 30 major-generals, were all ordered to prepare for active ſervice in the frontier armies.

The war between the Turks and Auſtrians was carried on with various ſucceſs. At firſt the advantage was evidently on the ſide of the Ottomans, and the imperial Joſeph acquired no warlike renown. His declared purpoſe was to get poſſeſſion of Belgrade; from which, however, he was repulſed with diſgrace. The prince of Saxe-Cobourg in his department of the war diſplayed indeed prodigies of valour; but being oppoſed to a ſuperior force, he was long obliged to act only on the defenſive. At length being joined by a body of Ruſſian forces under General Soltikof, preparations were made for commencing in form the ſiege of Choczim, which was ſurrendered to the allied armies on Michaelmas

mas day 1788, after a defence which would have done honour to the ableſt general in Europe, Still, however, ſucceſs ſeemed to lean to the Turks. The grand vizier made a ſudden incurſion into the Bannat, and ſpread conſternation and diſmay to the very gates of Vienna. The Auſtrian affairs ſeemed approaching to a very alarming criſis ; not only the ſplendid views of conqueſt which were beheld in the imagined partition of a tottering empire had totally diſappeared, but had left in their place the ſad and gloomy reverſe of a diſcontented and impoveriſhed people, an exhauſted treaſury, and an army thinned by peſtilence and deſertion. The firſt campaign of an invaſive war had already produced an impreſſion on the territory of the invader.

In this ſituation of affairs Marſhal Laudohn was with ſome difficulty drawn from his retirement to take the command of the army in Croatia ; and under his auſpices fortune began to ſmile on the Auſtrian arms. He quickly reduced Dubicza and Nevi, though they were both defended by the moſt obſtinate bravery. He then ſat down before Turkiſh Gradiſca ; but the autumnal rains coming on with ſuch violence, that the Save overflowed its banks, he was compelled to raiſe the ſiege. During this period the war in the Bannat raged with the utmoſt violence ; torrents of blood were ſhed on both ſides ; much deſperate valour diſplayed on the one ſide, and many brave actions performed on the other ; while a very great part of that fine but unfortunate country ſuffered all the deſolation and ruin that fire and ſword, under the dominion of vengeance and animoſity, could inflict. The inhabitants were objects of commiſeration ; but the injuſtice with which the emperor had commenced the war, made his perſonal loſſes be conſidered as nothing more than the due reward of his conduct.

29
Acceſſion of Selim III.
An. 1789.

In the midſt of theſe military operations Achmet IV. was depoſed, and ſucceeded by Selim III. the late ſultan. The new emperor did not want either courage or prudence, and he continued the war with Ruſſia and Auſtria, with great ſpirit and reſolution. Thoſe events of this war in which the Ruſſians were more immediately concerned, have been already noticed under the article Russia, N° 156, 158, 160 and 161 ; ſo that we have merely to relate the remaining operations of the Auſtrians.

30
Marſhal Laudohn takes Gradiſca and Belgrade.

Marſhal Laudohn renewed his attempts upon Gradiſca as ſoon as the ſeaſon would permit, and after a brave defence it fell into his hands. This, with ſome other ſucceſſes rouſed the emperor from his inactivity, and made him ſeriouſly determine on the attack which he had long meditated on Belgrade. The enterpriſe was intruſted to Laudohn, who, with that good fortune which ſeemed conſtantly to attend him, made himſelf maſter of the place in leſs than a month. The reſt of the campaign was little elſe than a ſeries of the moſt important ſucceſſes. While one detachment of General Laudohn's forces took poſſeſſion of Czernitz in Walachia, another made itſelf maſter of Cladova in Servia. Buchareſt, the capital of the former of theſe provinces, fell without oppoſition into the hands of Prince Cobourg ; while Akerman on the Black ſea was reduced by the Ruſſians ; and Bender ſurrendered to Prince Potemkin, not without ſuſpicion of ſiniſter practices, on the 15th of November.

31
Peace with Auſtria,
An. 1790.

Soon after this, the emperor Joſeph died, and his ſucceſſor Leopold ſhewed a deſire for peace. After the reduction of Orſova, therefore, which happened on the 16th of April 1790, the war was carried on with languor on the part of Auſtria ; and in the month of June a conference was agreed on at Reichenbach, at which the miniſters of Pruſſia, Auſtria, Britain, and the United Provinces, aſſiſted, and at which alſo an envoy from Poland was occaſionally preſent. After a negociation, which continued till the 17th of Auguſt, it was agreed that a peace ſhould be concluded between the king of Hungary and the Ottoman Porte ; that the baſis of this treaty ſhould be a general ſurrender of all the conqueſts made by the former, retaining only Choczim as a ſecurity till the Porte ſhould accede to the terms of the agreement, when it alſo was to be reſtored.

32
and with Ruſſia.

In the following year the Porte was compelled to conclude a peace with the empreſs of Ruſſia, and from that period till the depoſition of Selim in 1807, no event of conſequence has occurred. The Porte has alternately been at war with Britain and with France, but in neither conteſt has ſhe acquired either honour or territory. As the very confined limits to which we are now reduced forbid us to dwell on theſe minor tranſactions, we ſhall haſten to conclude this hiſtorical outline with an account of the revolution which placed Muſtapha IV. on the Ottoman empire.

33
Depoſition of Selim and acceſſion of Muſtapha IV.

In the ſpring 1807, the ſpirit of inſurrection had ſhown itſelf among the janizaries belonging to the garriſons of the Dardanelles, and in the camp of the grand vizier. In the afternoon of the 25th of May, the garriſons of the caſtles of the Dardanelles were in a ſtate of tumult, on account of the European uniform, the new tactics, &c. Hali Aga, the commandant of Madſchiaburna, on the Aſiatic ſhore, was murdered. Indſche Bey, commandant of the entrance of the Black ſea, only eſcaped the ſame fate by flight. The reis effendi happening to come to inſpect that poſt juſt at the ſame time, the military immediately roſe upon him as one of the introducers of the nizam geded. He endeavoured to ſave himſelf in a bark, by paſſing over to Buyukdere, but 100 piſtol ſhots laid him and his attendants dead. It ſeems that the rage of the janizaries had been embittered againſt him by the recollection of a promiſe he made to raiſe their pay, on condition they would adopt the new diſcipline, and which promiſe he never performed.

Another circumſtance increaſed the ſpirit of oppoſition ; the ſultan had given notice that the janizaries were no longer to attend him as uſual to the moſque, but that this duty was to devolve upon the troops diſciplined after the European manner. Thouſands of janizaries were now marching to Conſtantinople, and arrived in the ſuburb of Pera on the evening of the 28th. They ſwore to each other to conduct the revolution with the beſt order. Any perſon who ſhould in the leaſt injure any Frank was to ſuffer death. One individual janizary only met with his fate, for taking bread from a Greek (a baker), without paying for it. Behind the janizaries barracks, in the well-known place called Eimeldan, the janizaries planted their colours, and took with them their camp kettles ; an infallible ſignal of inſurrection. For a time, the ſultan thought of defending himſelf ; and troops, powder, and cannon, were brought to the ſeraglio. Soon after the mufti, the ſeimen baſche, the kaimakan, and the two kazcakars of Romelia and Natolia, joined the janizaries.

zaries. A council was held in form, and it was propoſed as a preliminary, to requeſt the grand ſeignior to aboliſh the new diſcipline by a fettiva from the mufti. The grand ſeignior, however, thought he ſhould be able to put a ſtop to the inſurrection before the ſtep could be taken, in conſequence of his ſending the heads of Mahmud, Terſana Emin, Hagai Ibrahim, and the kiaga Mehmeſch Effendi, to the Eimeldan. This meaſure completely failed; the janizaries were more enraged than ever; they did not require the heads of the univerſally eſteemed Mahmud Effendi, but that of the Reis Effendi, then in the camp of the grand vizier.

The janizaries continued to ſearch every place for thoſe miniſters, who had promoted the adoption of the European diſcipline, and publicly avowed themſelves as its patrons, namely, Franſiſto, Ibrahim, Juſſuf Aga, Hadſchi Ibrahim, and Achmet Bey, captains of the grand ſeignior's guard; Haſſan Aga, Achmet Effendi, and others, 12 in number, who were all taken, dragged to the Eimeldan, and there cut to pieces. At this juncture the grand ſeignior ſent a hatti ſcheriff, a letter written in his own hand, in which he for ever aboliſhed the nizam geded, and pronounced an execration on it. But the hatti ſcheriff was not now accepted; the depoſition of the grand ſeignior was reſolved on. The whole force of the janizaries now proceeded to the ſeraglio. The mufti and the ullemas alone entered the haram, while the reſt of the miniſters, the agas, the janizaries, and the people, ſurrounded the palace.

Muſtapha IV. born on the 7th of September 1799, the eldeſt ſon of the ſultan Achmet IV. ſet aſide in 1789, was raiſed to the Turkiſh throne. And according to ancient cuſtom, Selim, the former ſultan, threw himſelf at the feet of Muſtapha, kiſſed the border of his garment, and immediately repaired to that department of the ſeraglio occupied by the princes of the Ottoman blood who no longer reign. The ſolemn invitation to Muſtapha, to aſcend the throne, was made on the 29th of May, and on the 3d of June the ceremony of inveſting him with the ſabre of the prophet, took place.

34
Population of Turkey.

The population of the whole Turkiſh empire is uſually eſtimated at 18,000,000. Of theſe, 10,000,000 have been allotted to Aſiatic Turkey, and the remaining 8,000,000 to Turkey in Europe. A conſiderable part of this population conſiſts of Jews and mercantile Chriſtians, from different parts of Europe, who are diſtinguiſhed by the name of Franks.

35
Government.

The government of Turkey is deſpotic, but the power of the ſultan is by no means ſo abſolute as we are generally led to ſuppoſe. Beſides, being ſtrictly ſubject to the laws of the Koran, and thus to the national religion, ſuch obſtructions to his abſolute will are raiſed by the power of the mufti, or chief prieſt and judge, by the frequent inſurrections of the janizaries, and the ambition of the pachas, or governors of provinces, that many Chriſtian ſovereigns are much more deſpotic. The principal title of the ſultans is, as we have ſeen, grand ſeignior, and the court of Conſtantinople is uſually ſtyled the Porte, or Ottoman Porte, either from the large gate at the entrance of the ſeraglio, or, what is more probable, from the palace of the vizier, where all the affairs of ſtate are tranſacted. The principal miniſters of the Porte are the grand vizier or prime miniſter, the mufti, the reis effendi or chief ſecretary of ſtate, the kiſlar-aga or chief of the black eunuchs, and the aga of the janizaries.

36
Revenues.

The revenues of the whole Turkiſh empire are computed at about 7,000,000l. Sterling, while the uſual expence does not exceed 5,000,000l. This revenue is partly derived from the capitation tax on unbelievers and from the cuſtoms, but principally from the tax on land, amounting to about 6s. per acre. The ſultan is alſo ſuppoſed to poſſeſs a conſiderable private treaſure, but of this nothing certain is known.

37
Military ſtrength.

The military ſtrength of Turkey is but inconſiderable for ſo large an empire. The whole of the land forces are ſuppoſed never to exceed 150,000 men, and theſe are ill diſciplined, and now diſpirited by ſucceſſive diſaſtrous wars. The navy is eſtimated at 30 ſail of the line; but the ſhips are ill-built, badly manned, and wretchedly navigated. In ſhort, the military ſtrength of the Ottoman empire is not improperly ſaid to be more deſtructive to its own provinces than to any ſtate with which they are at war, and more terrible to its friends than its enemies.

38
Religion and laws.

The eſtabliſhed religion of Turkey is Mahometaniſm, the tenets of which have been already explained under the articles MAHOMETANISM and ALCORAN. The laws of the empire are entirely founded on the Koran; but in particular caſes the judges are guided by certain commentaries on that work, which have acquired the force of laws. The chief of theſe are the commentaries of Abou-Hanife.

The mufti, or Mohammedan pontiff, preſides at Conſtantinople, but his power has ſeldom interfered with the civil government. Next to him in rank are the moulahs, who, though eſteemed dignitaries of the church, are in fact rather doctors of the law, while the Koran is alſo a code of civil obſervance. From the moulahs are ſelected the inferior muftis or judges throughout the empire, and the cadeleſquiers, or chief juſtices. The next claſs of divines includes the imaums, or pariſh prieſts, who perform the ſervice of the moſques, while the cadis are judges annually appointed to adminiſter juſtice in the towns and villages, and being regarded as churchmen, like the moulahs, have directed their chief attention to the judicial part of the Koran. From this brief view it will be obſerved, that the eccleſiaſtical orders of muftis and imaums ſomewhat reſemble the Chriſtian biſhops and parochial clergy; while the other diſtinctions ariſe from the ſingularity of both religion and laws being united in the Koran, ſo that a lawyer or judge muſt be at the ſame time a ſkilful divine. The Turks have alſo their monks, ſtyled derviſhes, of four various orders and inſtitutions, dedicated by ſolemn vows to religious offices, public prayer, and preaching. The Greeks, along with their faith, retain their prieſts, biſhops, archbiſhops, and patriarchs; but their church is in the laſt ſtate of degradation, and its dignities openly ſold by the Turks; this abomination, however, it muſt be confeſſed, partly ariſes from the miſerable ambition and avarice of the Greek eccleſiaſtics, who think they can atone by idle ceremonies for the neglect of all the invaluable morality of the goſpel.

39
Language and literature.

The Turkiſh language is of far inferior reputation to the Perſian or Arabic, being a mixture of ſeveral dialects, and poſſeſſing neither the force, elegance, nor purity

rity of theſe two celebrated oriental tongues. Literature, however, is not wholly neglected, and it has been repeatedly attempted to eſtabliſh a printing preſs at Conſtantinople; but the deſign failed from the intereſt of the copyiſts, who inferred that this art would deprive them of their bread. A late traveller informs us that there are in this capital ſeveral *kuttub-chans*, or public libraries, among which are thoſe of St Sophia, and the Solimanie Jamaſy; but none are ſo elegant as that founded by the grand vizier Raghid, which is wholly built of marble in the midſt of a ſquare court, and is filled with books chiefly theological. A librarian conſtantly attends, and there are convenient ſeats with carpets and cuſhions. In the neighbourhood is a ſchool founded by the ſame vizier, in which about 100 boys are taught to read and write. The market for books is extenſive, containing many ſhops well ſupplied with oriental manuſcripts. The Turks have their ancient poets, hiſtorians, and divines; but of little reputation when compared with thoſe of Perſia or Arabia. The ſtate of education among the Turks may be conceived to be very low, and ignorance is indeed a chief part of the national character. The only profeſſion which requires a ſhadow of learning is that of the law, which is intimately connected with their theology. The celebrated doctors have diſciples, who are trained up to that department; but there ſeems nothing that can deſerve the name of college or univerſity.

40
Of commerce.

The Turks cannot be regarded as a commercial people, though they admit of an extenſive commercial intercourſe with the ſtates of Europe, through the medium of Frank and Greek merchants. The chief ports are Smyrna and Conſtantinople, the former of which is the great centre of the Levant trade, while the latter is concerned chiefly in the trade with Ruſſia, by the Black ſea. At both theſe ports, and indeed throughout the Turkiſh empire, the trade is nominally carried on by factors from the different European ſtates; but it is managed more immediately by Jew or Armenian brokers, who take numerous advantages of the ignorance of the factors, and ſeldom fail to enrich themſelves at the expence of their employers. The commodities exported from Turkey, chiefly to Britain, Germany, Italy, Holland, and France, conſiſt for the moſt part of bees wax, boxwood, ſilk, cotton yarn, walnut planks, ſponges, opium and other drugs enumerated in N° 9, madder root, and other dye ſtuffs, and various dried fruits, ſuch as figs, raiſins, and currants. The imports are chiefly tin and tin plates, ſugar, ſhalloons, cotton yarn and cotton goods, muſlins, clocks and watches, cutlery and glaſs ware, indigo, gunpowder, piſtols and military ſtores, logwood, rum, coffee, and various ſpices, eſpecially pepper, ginger, and cinnamon. The exports are principally from Smyrna, where the trade is carried on almoſt entirely by way of exchange, while at Conſtantinople the imports are generally paid for by caſh or bills. The exchange is commonly againſt the Turks.

The Turkiſh money uſually employed in commerce is the piaſtre, which, according to the exchange or agio, is rated at from 13 to 17 in the Engliſh pound ſterling, ſo that the average value of the piaſtre is about 1s. 6d. Each piaſtre is divided into 40 paras, and each para into three aſpers. The principal weight employed is the kintal, equal to about one cwt. Engliſh, divided into 44 oke, and each oke into 400 drahen.

41
Character of the Turks.

From their jealouſy with reſpect to ſtrangers, it is extremely difficult to form a true eſtimate of the national character of the Turks. An intelligent writer, who ſeems well qualified to direct our judgement in this reſpect, has thus delineated the Turkiſh character. "The Turks are in general a ſagacious, thinking people; in the purſuit of their own intereſt, or fortune, their attention is fixed on one object, and they perſevere with great ſteadineſs until they attain their purpoſe. They are in common life ſeemingly obliging and humane, not without appearances of gratitude: perhaps all or either of theſe, when extended towards Chriſtians, are practiſed with a view of ſome advantage. Intereſt is their ſupreme good; where that becomes an object of competition, all attachment of friendſhip, all ties of conſanguinity, are diſſolved; they become deſperate, no barrier can ſtop their purſuit, or abate their rancour towards their competitors. In their demeanour they are rather hypochondriac, grave, ſedate, and paſſive; but when agitated by paſſion, furious, raging, ungovernable; big with diſſimulation; jealous, ſuſpicious, and vindictive beyond conception; perpetuating revenge from generation to generation. In matters of religion, tenacious, ſupercilious, and moroſe". *

42
Manners and cuſtoms.

The manners and cuſtoms of the Turks are diſtinguiſhed by the peculiarity of their religion from thoſe of other European nations. On the birth of a child the father himſelf gives the name, putting at the ſame time a grain of ſalt into its mouth. The circumciſion is not performed till the age of 12 or 14. Marriage is only a civil contract, which either party may break, and is managed by female mediation, the youth ſeldom ſeeing his bride till after the ceremony. The dead are perfumed with incenſe, and buried in a cloth, open at top and bottom, that the deceaſed may be able to ſit up and anſwer the queſtions of the angels of death. The burial-grounds are near the highways, and ſtones are often placed at the heads of the graves, with carved turbans denoting the ſex. As they never intrench upon a former grave, the cemeteries are very extenſive. In diet the Turks are extremely moderate, and their meals are diſpatched with great haſte. Rice is the favourite food, and is dreſſed in three ways. In boiling, the meat is cut into ſmall pieces, and in roaſting ſtill ſmaller, a bit of meat and an onion being placed alternately on a very long ſpit. The fiſh of the Archipelago are excellent, and the beef tolerable, except that of the buffalo, which is very hard. The hares, partridges, and other game, are of ſuperior flavour. The meal is uſually ſpread on a low wooden table, and the maſter of the houſe pronounces a ſhort prayer. The frugal repaſt is followed by fruits and cold water, which are ſucceeded by hot coffee and pipes with tobacco. The houſes of the Turks are ſeldom expenſive; the chief furniture is the carpet which covers the floor, with a low ſofa on one ſide of the room. In regard to dreſs, Tournefort obſerves that the uſe of the turban is unhealthy. The ſhirt is of callico, and the looſe robe is faſtened by a girdle, in which is ſtuck a dagger, while the tobacco box, pocket-book, &c. are worn in the boſom. The robe is generally of European broad cloth, trimmed with various furs. The ſhoes or ſlippers are ſlight, and unfit for much exerciſe. The dreſs of the women differs little from that of the men, the chief diſtinction being the head-dreſs; that of the fair ſex conſiſting of a bonnet

like

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* Potter's *Obſervations on the Religion, Manners, &c. of the Turks*, vol. i. p. 4.

like an inverted baſket, formed of paſteboard covered with cloth of gold, with a veil extending to the eyebrows, while a fine handkerchief conceals the under part of the face. The perſonal cleanlineſs of both ſexes is highly laudable; but the European eye is not pleaſed with the female cuſtom of ſtaining the nails with a red tincture. The amuſements of the Turks partake of their indolent apathy, if we except hunting, and thoſe of a military deſcription. To recline on an elegant carpet, or in a hot ſeaſon by the ſide of a ſtream, and ſmoke the delicate tobacco of Syria, may be regarded as their chief amuſement. Cheſs and draughts are favourite games; but thoſe of chance are conſidered as incompatible with ſtrict morals. The coffee-houſes and baths furniſh other ſources of amuſement; and the bairam, or feſtival which follows their long lent, is a ſeaſon of univerſal diſſipation. *

It appears to be a miſtaken notion, that the practice of eating opium, to procure intoxication, is general among the Turks. We are aſſured by a late traveller, that this practice is confined to a few individuals, who are regarded by the majority of their countrymen with as much contempt as drunkards are in the more poliſhed ſocieties of Europe.

TURKEY. See MELEAGRIS, ORNITHOLOGY *Index*.

TURMERIC. See CURCUMA, BOTANY *Index*.

TURNEP, a ſpecies of BRASSICA. See BOTANY *Index*; and for the culture, ſee AGRICULTURE *Index*.

TURNEP-Bread. See BREAD.

TURNEP-Fly. See CHRYSOMELA, ENTOMOLOGY *Index*.

TURNING, the art of forming hard bodies, as wood, ivory, iron, into a round or oval ſhape, by means of a machine called a *lathe*.

This art was well known to the ancients, and ſeems to have been carried by them to a very great degree of perfection; at leaſt, if we believe the teſtimony of Pliny and ſeveral other authors, who tell us, that thoſe precious vaſes enriched with figures in *half-relief*, which ſtill adorn our cabinets, were turned on the lathe.

The art of turning is of conſiderable importance, as it contributes eſſentially to the perfection of many other arts. The architect uſes it for many ornaments, both within and without highly finiſhed houſes. The mathematician, the aſtronomer, and the natural philoſopher, have recourſe to it, not only to embelliſh their inſtruments, but alſo to give them the neceſſary dimenſion and preciſion. In ſhort, it is an art abſolutely neceſſary to the goldſmith, the watchmaker, the joiner, the ſmith.

Turning is performed by the lathe, of which there are various kinds, and ſeveral inſtruments, as gouges, chiſels, drills, formers, ſcrew tales, uſed for cutting what is to be turned into its proper form as the lathe turns round. The following is a ſimple kind of lathe (fig. 1.), in which *a* is the footſtool, *b* the cord, *c* the frame of the lathe, *d d* the puppets, *e e* the points, *f* the ſpanging-tree.

Plate DXL. Fig. 1.

The lathe ſhould be fixed in a place very well lighted; it ſhould be immoveable, and neither too high nor too low. The puppets ſhould neither be ſo low as to oblige the workman to ſtoop in order to ſee his work properly, nor ſo high that the little chips, which he is continually driving off, ſhould come into his eyes.

The piece to be turned ſhould be rounded (if it be wood) before it be put on the lathe, either with a ſmall hatchet made for the purpoſe, or with a plane, or with a file, fixing it in a vice, and ſhaving it down till it is everywhere almoſt of an equal thickneſs, and leaving it a little bigger than it is intended to be when finiſhed off. Before putting it on the lathe, it is alſo neceſſary to find the centres of its two end ſurfaces, and that they ſhould be exactly oppoſite to each other, that when the *points* of the puppets are applied to them, and the piece is turned round, no ſide may belly out more than another. To find theſe two centres, lay the piece of wood to be turned upon a plank; open a pair of compaſſes to almoſt half the thickneſs of the piece; fix one of the legs in the plank, and let the point of the other touch one of the ends of the piece, brought into the ſame plane with the plank on which the compaſſes is fixed and very near the fixed leg. Deſcribe four arches on that end at equal diſtances from each other at the circumference of the end, but interſecting one another within; the point of interſection is the centre of the end. In the ſame manner muſt the centre of the other end be found. After finding the two centres, make a ſmall hole at each of them, into which inſert the points of the puppets, and fix the piece ſo firmly as not to be ſhaken out, and yet looſe enough to turn round without difficulty.

The piece being thus fixed, it is neceſſary in the next place to adjuſt the cord, by making it paſs twice round the piece, and in ſuch a manner that the two ends of the cord, both that which is fixed to the *ſpang* and to the *foot-board*, come off on the ſide on which the turner ſtands, that the piece may move againſt the edge of the cutting-tool and be turned. If the lathe be moved by a wheel, the manner of adjuſting the cord needs no directions.

If the workman does not chooſe to be at the trouble to find the two centres of the piece in the manner deſcribed above, let him lay, as nearly as he can, the centre of one end upon the *point* of the left hand *puppet*, and then let him puſh forward the right hand puppet, ſtriking it with a mallet till its point is as near as he can in the centre of the other end of the piece; and then fixing the right hand puppet by a gentle blow of the mallet on the key, let him turn round the piece to ſee by the eye if the centres have been properly found. If any part of it bellies out, let him ſtrike that part gently with the mallet till it goes properly; then let him ſtrike one of the puppets pretty ſmartly to drive the points into the piece, and afterwards fix the puppet by ſtriking the key. If the workman cannot judge by the eye whether the piece be turning properly round its centres or not, he ſhould apply gently the point of an inſtrument called a *triangular graver*, leaning it on the *reſt*, and it will mark by a line the place where the piece is out of its centre; and by ſtriking upon this line with a mallet, the piece can eaſily be placed properly. The *reſt*, of which we have juſt ſpoken, ought to be placed upon the two arms of the lathe, and fixed with ſcrews as near the piece as the workman pleaſes.

The piece being fixed between the two points of the puppets (or, as they are called in Scotland, the *heads*), the cord adjuſted, and the *reſt* fixed as near the work as poſſible without touching it; the workman is now to take a *gouge* (fig. 2. in which *a* is the mouth and *b* the handle) of a proper ſize in his left hand, and hold it by the handle a little inclined, keeping the back of the hand

Fig. 2.

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* *Pinkerton's Geography.*

hand lowermoſt. With his right hand, the back of which is to be turned upwards, he is to graſp it as near the end as poſſible on this ſide of the *reſt;* then leaning the gouge on the *reſt*, he is to preſent the edge of it a little higher than the horizontal diameter of the piece, ſo as to form a kind of tangent to its circumference; then putting the right foot on the foot-board, and turning round the wheel, and holding the gouge firmly on the *reſt*, the piece will be cut neatly. In the ſame manner are the chiſels, formers, and other inſtruments to be uſed, taking care that the wood be cut equally, and that the inſtrument be not puſhed improperly, ſometimes ſtronger than at others; and taking care alſo that the inſtrument uſed do not follow the work, but that it be kept firmly in the hand without yielding.

The young turner ought to endeavour to acquire the management of the gouge and the chiſel, which are the inſtruments by far the moſt frequently uſed, and the moſt neceſſary in this art: by them, almoſt entirely, are the ſoft woods *turned;* for as for hard woods and other things, as box, ebony, horn, ivory, and the metals, they are hardly ever turned except by *ſhaving off*. In that caſe gravers are to be uſed with ſquare, round, or triangular mouths (fig. 3, 4, 5.). They ſhould be held horizontally while applied to the wood, and not obliquely as directed for the gouge and the chiſel.

Fig. 3, 4, and 5.

After the work is completely turned, it is next to be poliſhed; and this cannot be done with the inſtruments hitherto mentioned. Soft woods, as pear-tree, hazel, maple, ought to be poliſhed with ſhark-ſkin or Dutch ruſhes. There are different ſpecies of ſharks; ſome of which have a grayiſh, others a reddiſh ſkin. Shark-ſkin is always the better to be a good deal uſed; at firſt it is too rough for poliſhing. The *Dutch-ruſh (equiſetum hyemale)*, which grows in moiſt places among mountains, and is a native of Scotland. The oldeſt plants are the beſt. Before uſing them they ſhould be moiſtened a little, otherwiſe they break in pieces almoſt immediately, and render it exceedingly difficult to poliſh with them. They are particularly proper for ſmoothing the hard woods, as box, lignum vitæ, ebony, &c. After having cleaned up the piece well, it ſhould be rubbed gently either with wax or olive-oil, then wiped clean and rubbed with its own raſpings or with a cloth a little worn. Ivory, horn, ſilver, and braſs, are poliſhed with pumice-ſtone finely pounded and put upon leather or a linen cloth a little moiſtened: with this the piece is rubbed as it turns round in the lathe; and to prevent any dirt from adhering to any part of it, every now and then it is rubbed gently with a ſmall bruſh dipt in water. To poliſh very finely, the workmen make uſe of tripoli, a particular kind of earth, and afterwards of putty or calx of tin. Iron and ſteel are poliſhed with very fine powder of emery; this is mixed with oil, and put between two pieces of very tender wood, and then the iron is rubbed with it. Tin and ſilver are poliſhed with a burniſher and that kind of red ſtone called in France *ſanguine dune*. They may be poliſhed alſo with putty, putting it dry into ſhamoy-ſkin, or with the palm of the hand.

To ſucceed in turning iron, it is neceſſary to have a *lathe* exceedingly ſtrong in all its parts, and exceedingly well fixed. The puppets ſhould be ſhort, and the *reſt* well fixed very near the work: the back of the *reſt* ſhould be two or three lines lower than the iron to be turned.

The lathe and other inſtruments being prepared, it is neceſſary to determine the length and thickneſs of the iron to be turned according to the deſign which is to be executed, and to make a model of it in wood a little thicker than it ought to be: Then one exactly like this is to be forged of the beſt iron that can be procured; that is to ſay, it muſt not be new, but well prepared and well beaten with hammers; it muſt have no flaws, nor cracks, nor pimples. New iron, which has not been well beaten, often contains round drops of caſt iron, called by the workmen *grains*, which blunt the edges of the gouges, chiſels, and other inſtruments uſed for cutting, break them, or make them ſlide. The iron being forged according to the model, it ſhould be annealed, that is, heated red hot and allowed to cool ſlowly on the coals till the fire go out of itſelf. Some people, to ſoften the iron, cover it over with clay and allow it to cool. The iron cylinder being thus made, it is next to be put upon the lathe, finding the centres as formerly directed, and boring a ſmall hole in them that the iron may not eſcape from the points.

The points ſhould be oiled from time to time to prevent their being exceſſively heated and ſpoiled while the iron is turning. A *crotchet* is then to be applied to the iron to be turned, a little above its centre, pretty gently, and by this means the inequalities of the cylinder will be taken off. Other inſtruments are then to be applied to mold the iron according to the model; and whenever any of them grow hot, they are to be plunged into a baſon of water lying beſide the workman. If the iron, after being properly turned, is to be bored like a gun-barrel, one of the puppets is to be removed and another ſubſtituted in its place, having a ſquare hole through it, into which the collar of the iron is to be fixed firmly, ſo as not to ſhake; then borers are to be applied, like thoſe which lockſmiths uſe to bore keys; and beginning with a ſmall one, and afterwards taking larger ones, the hole is to be made as wide and deep as neceſſary; great care muſt be taken to hold the borers firm on the *reſt*, otherwiſe there is danger of not boring the hole ſtraight. The borer muſt be withdrawn from time to time to oil it and to clean the hole. Since it is difficult to make a hole quite round with borers alone, it is neceſſary to have alſo an inſtrument a good deal ſmaller than the hole, one of the ſides of which is ſharp, very well tempered, and a little hollow in the middle. This inſtrument being fixed in a pretty long handle, is to be applied with ſteadineſs to the inner ſurface of the hole, and it will entirely remove every inequality that may have been there before its application.

To cut a ſcrew upon the cylinder, ſome perſons uſe an inſtrument conſiſting principally of a female ſcrew; but this is rather an improper inſtrument; for if one preſſes too violently, or inclines it ever ſo little to the right or left, he runs the greateſt riſk of ſpoiling the ſcrew. To avoid this danger, ſome uſe it only to trace out the lines of the ſcrew, and afterwards finiſh it with a file. But the following is a much better way. Take a tap for making a female ſcrew, the threads of which have been cut very accurately, and exactly of the ſize of the ſcrew which you want; and having put it in the opening which you have traced in the collar of the

TURNING.

Plate DXL.

Fig. 1.

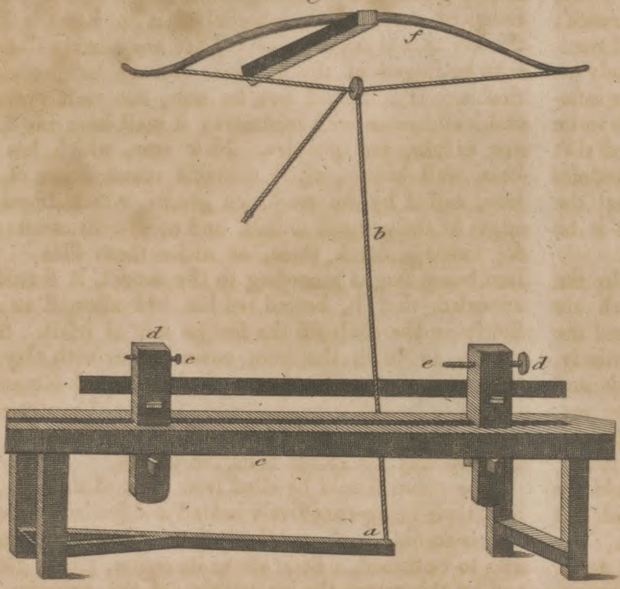


Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

VARIATION of the Compass.

Fig. 1.

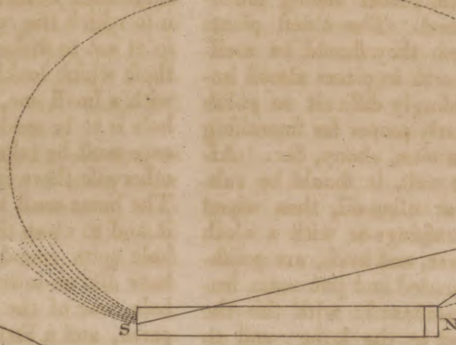


Fig. 3.

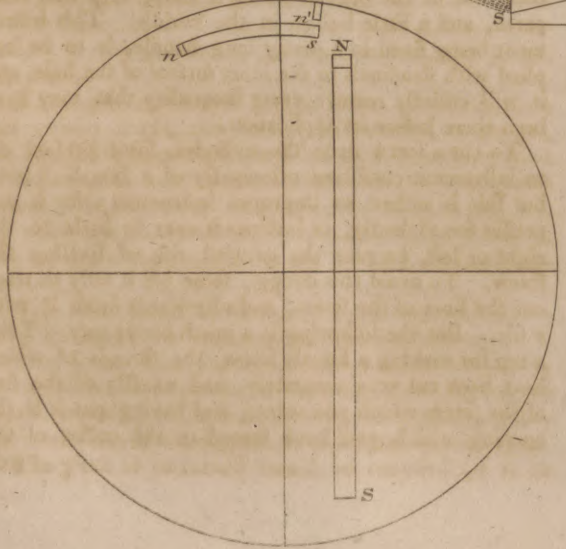
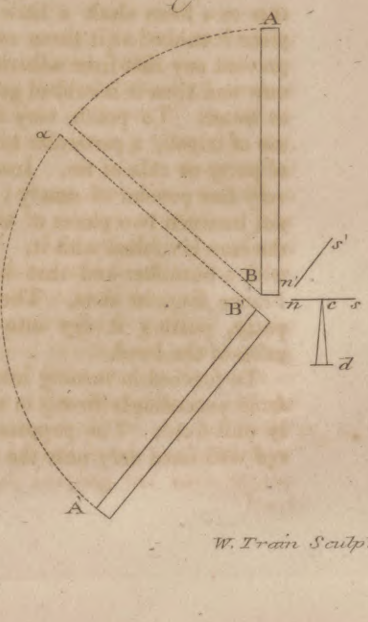


Fig. 2.



W. Train Sculp^t.

axis on which the ſcrew is to be cut, ſolder it with tin, ſal-ammoniac, and roſin, as exactly correſponding to the axis as poſſible. Take then a puppet with a hole cut into a correſponding female ſcrew, into which the male ſcrew is to be put. The axis on which the ſcrew is to be cut muſt be placed exactly horizontally between the two puppets. The *reſt* is then to be brought as near as poſſible to the place where the ſcrew is to be cut, and a ſmall hollow ſhould be cut in that part of it which is exactly oppoſite to the place where the ſcrew is to be cut, to hold your inſtrument firmly and prevent it from ſhaking. The inſtrument with which the ſcrew is to be cut ſhould be very ſharp, and its point ſhould make an angle of 60° with the ſcrew to be cut; and if you wiſh the ſcrew to be cut very deep, it ſhould make an angle a little larger. The lathe being now put in motion, the tap fixed at the end of the axis will move gradually through the female ſcrew in the puppet; and your inſtrument in the mean time will trace a ſimilar male ſcrew on the axis fixed in the lathe. Many perſons, after having in this manner drawn the outlines of the ſcrew, finiſh it with a ſcrew-tale of three teeth correſponding exactly to the ſize of the ſcrew, or with a triangular file; but this laſt method is rather improper.

For turning ovals, a lathe of ſomewhat a different conſtruction is uſed. The axis or ſpindle, having on it the pulley over which the band-cord paſſes for turning the lathe, is fixed between the two puppets ſo as to turn round eaſily: one end of it paſſes through one of the puppets, and to it is firmly fixed a circular plate of braſs, ſo that it turns round along with the ſpindle. Upon this plate two brazen ſegments of circles are faſtened, the circumferences of which correſpond to the circumference of the plate: their chords are parallel, and equally diſtant from the centre of the plate, ſo that they leave a diſtance between them. They have a groove in each of them: in theſe grooves another plate is placed which exactly fills up the ſpace between the two grooves, but is ſhorter than the diameter of the larger circular plate on which it is laid. This plate is made to ſlide in the grooves. To its centre is fixed a ſhort ſpindle, on which the piece of wood to be turned is fixed. When the lathe is ſet a going, the circular plate moves round, and carries the piece along with it; the plate of braſs on which the piece is fixed being fixed looſely in the grooves already deſcribed, ſlides down a little every time that the grooves become perpendicular to the floor (and there are particular contrivances to prevent it from ſliding down too far); and by theſe two motions combined, the circular one of the large plate, and the ſtraight one of the ſmall, the circumference of the piece of wood to be turned neceſſarily deſcribes an oval; and gouges or other tools being applied in the uſual manner ſupported on the *reſt*, it is cut into an oval accordingly. The ſmall plate may be made to ſlide either more or leſs in the grooves; and by this contrivance the tranſverſe diameter of the oval, or rather ellipſe, may be made longer or ſhorter at pleaſure.

1. *The method of moulding boxes of ſhell and horn.*—In the firſt place, form a proper mould, which muſt conſiſt of two pieces, viz. of a circle about half an inch thick, which ſhould ſlope a little in order to draw out the moulded ſhell the more eaſily; and a ring fitted to the outſide of the circle, ſo that both together make the ſhape of a box. Theſe two pieces being adjuſted, it is neceſſary to round the ſhell to be moulded of ſuch a ſize that, when moulded, it will be a little higher than the ring of the mould, that there may be no deficiency. The mould is then to be put into a preſs on a plate of iron, exactly under the ſcrew of the preſs; put then the ſhell upon the circle of the mould, ſo that its centre alſo is exactly oppoſite to the ſcrew of the preſs: then take a piece of wood formed into a truncated cone, and not ſo thick as the diameter of the circle of the mould, nor ſo deep as the ring: then put a plate of iron above the cone, and ſcrew down the preſs gently and cautiouſly till the whole is well fixed: then plunge the whole into a cauldron of boiling water placed above a fire. In 8 or 10 minutes the ſhell or horn will begin to ſoften; ſcrew the preſs a little firmer that the wooden cone may ſink into the ſoftened ſhell: repeat this from time to time till the cone is quite ſunk in the mould; then take out the preſs and plunge it into cold water. When it is cold, take the box now formed out of the mould, and put into the inſide of it a new mould of tin exactly of the form you wiſh the inſide of the box to be; do the ſame with the outſide, put it again into the preſs and plunge it into boiling water; ſcrew the preſs gradually till the box receive the deſired form.

2. *Method of preparing green wood ſo that it will not ſplit in the turning.*—Cut the wood into pieces of a proper ſize, put them into a veſſel full of potaſh ley. Boil them about an hour; take the cauldron from the fire, allow the ley to cool; and take out the wood and dry it in the ſhade.

3. *Method of giving an ebony-black to hard and fine woods.*—After forming the wood into the deſtined figure, rub it with aquafortis a little diluted. Small threads of wood will riſe in the drying, which you will rub off with pumice-ſtone. Repeat this proceſs again, and then rub the wood with the following compoſition: Put into a glazed earthen veſſel a pint of ſtrong vinegar, two ounces of fine iron-filings, and half a pound of pounded galls, and allow them to infuſe for three or four hours on hot cinders. At the end of this time augment the fire, and pour into the veſſel four ounces of copperas, and a chopin of water having half an ounce of borax and as much indigo diſſolved in it; and make the whole boil till a froth riſes. Rub ſeveral layers of this upon the wood; and when it is dry, poliſh it with leather, on which you have put a little tripoli.

4. *Method of giving to plum-tree the colour of brazil wood.*—Slake lime with urine, and bedaub the wood over with it while it is hot: allow it to dry; then take off the coat of lime and rub it with ſhamoy ſkin well oiled. Or, ſteep the wood in water, having a quantity of alum diſſolved in it: then, having allowed brazil wood to diſſolve in water five or ſix hours, ſteep the wood in it, kept lukewarm during a night; and when it is dry, rub it, as before directed, with ſhamoy ſkin well oiled.

5. *Method of giving a fine black colour to wood*—Steep the wood for two or three days in lukewarm water in which a little alum has been diſſolved; then put a handful of logwood, cut ſmall, into a pint of water, and boil it down to leſs than half a pint. If you then add a little indigo, the colour will be more beautiful. Spread a layer of this liquor quite hot on the wood with a pencil, which will give it a violet colour.

When it is dry, ſpread on another layer; dry it again and give it a third: then boil verdegriſe at diſcretion in its own vinegar, and ſpread a layer of it on the wood: when it is dry, rub it with a bruſh, and then with oiled ſhamoy ſkin. This gives a fine black, and imitates perfectly the colour of ebony.

6. *Method of cleaning and whitening bones before uſing them.*—Having taken off with a ſaw the uſeleſs ends of the bones, make a ſtrong ley of aſhes and quicklime, and into a pailful of this ley put four ounces of alum, and boil the bones in it for an hour; then take the veſſel containing the ley off the fire, and let it cool; then take out the bones and dry them in the ſhade.

7. *Method of ſoldering ſhells.*—Clean the two ſides of the ſhells which you wiſh to join together; then, having joined them, wrap them up in linen folded double and well moiſtened; then heat two plates of iron pretty hot that they may keep their heat for ſome time; and putting the ſhells rolled up between them under a preſs, which you muſt ſcrew very tight, leave them there till the whole is cold, and they will be ſoldered. If you do not ſucceed the firſt time, repeat the proceſs.

8. *Method of moulding ſhells.*—Put ſix pints of water into a kettle; add to it an ounce of olive or other oil; make the water boil; then put in your ſhell, and it will grow ſoft. Take it out and put it into a mould under a preſs, and it will take the figure you want. This muſt be done quickly; for if the ſhell cool ever ſo little, the proceſs will fail. It will not require much preſſure.

9. *Method of tinging bones and ivory red.*—Boil ſhavings of ſcarlet in water. When it begins to boil, throw in a quarter of a pound of aſhes made from the dregs of wine, which will extract the colour: then throw in a little rock alum to clear it, and paſs the water through a linen cloth. Steep the ivory or bone in aquafortis, and put it into the water. If you wiſh to leave white ſpots, cover the places deſtined for them with wax.

10. *To tinge ivory black.*—Steep the ivory during five or ſix days in water of galls with aſhes made with dried dregs of wine and arſenic; then give it two or three layers of the ſame black with which plum-tree is blackened, in order to imitate ebony. Or, diſſolve ſilver in aquafortis, and put into it a little roſe-water. Rub the ivory with this, and allow it to dry in the ſun.

11. *Method of hardening wood to make pulleys.*—After finiſhing the pulley, boil it ſeven or eight minutes in olive oil, and it will become as hard as copper.

12. *To make Chineſe varniſh.*—Take of gum lac in grains four ounces; put it into a ſtrong bottle with a pound of good ſpirit of wine, and add about the bulk of a hazel nut of camphor. Allow them to mix in ſummer in the ſun, or in winter on hot embers for 24 hours, ſhaking the bottle from time to time. Paſs the whole through a fine cloth, and throw away what remains upon it. Then let it ſettle for 24 hours, and you will find a clear part in the upper part of the bottle, which you muſt ſeparate gently, and put into another vial, and the remains will ſerve for the firſt layers.

TURNSTONE. See TRINGA, ORNITHOLOGY *Index.*

TURPENTINE, a tranſparent viſcous ſubſtance, flowing either naturally or by inciſion from ſeveral reſinous trees; as the terebinthus, pine, larch, fir, &c. See PINUS, BOTANY *Index.* See alſo CHEMISTRY and MATERIA MEDICA *Index.*

Oil of TURPENTINE. See CHEMISTRY and MATERIA MEDICA *Index.*

TURPETH, the cortical part of the root of a ſpecies of convolvulus. See MATERIA MEDICA *Index.*

TURQUOISE, is the tooth of an animal penetrated with copper ore.

TURRITIS, TOWER-MUSTARD; a genus of plants belonging to the claſs tetradynamia; and in the natural ſyſtem ranging under the 39th order, *Siliquoſæ.* See BOTANY *Index.*

TURTLE. See TESTUDO, ERPETOLOGY *Index.*

TURTLE-Dove. See COLUMBA, ORNITHOLOGY *Index.*

TUSCAN ORDER, in *Architecture.* See ARCHITECTURE, N° 42.

TUSCAN Earth, a yellowiſh kind of bole found in many parts of Italy, and particularly about Florence, where there is a ſtratum eight or ten feet thick, at the depth of five or ſix feet from the ſurface. It is ſuppoſed to have an aſtringent property.

TUSCANY, a duchy of Italy, which makes part of the ancient Hetruria, and, excepting ſome detached parts, is encompaſſed by a part of the Mediterranean, called here the *Tuſcan Sea;* the eccleſiaſtical ſtate; the duchy of Modena; and the republic of Lucca; its extent from north to ſouth being about 116 Engliſh miles, and from eaſt to weſt about 80.

Though ſome parts of it are mountainous, yet both the hills and dales are covered with vines, olives, citron, lemon, and orange trees, &c. The mountains yield alſo copper, iron, alum, &c. and ſome of the fineſt marble. Here is alſo plenty of corn, rice, ſaffron, honey, wax, wool, flax, hemp, with mineral waters, rich paſture, ſalt-pits, ſulphur, alabaſter, calcedony, lapis lazuli, borax, amethyſts, carnelians, jaſpers, cryſtals, and black ſlate. In ſome places the elms and aſhes yield manna.

The principal river in Tuſcany is the Arno, which has its ſource in the Apennine mountains, and falls into the ſea below Piſa. There are ſome other ſmaller rivers.

This duchy fell under the dominion of the Romans about 455 years before Chriſt. The Oſtrogoths poſſeſſed themſelves of it in the fifth century, and after them the Lombards, who were expelled by Charlemagne anno 800; in conſequence of which it became ſubject to the German emperors, who appointed governors over it. At laſt the cities of Florence, Piſa, Sienna, and ſome others, during the contentions between the pope and the emperor, and their reſpective adherents, the Guelphs and Gibbelines, withdrew themſelves from the dominion of both, and erected themſelves into ſeparate commonwealths. In that of Florence, John de Medicis, a popular nobleman, ſo inſinuated himſelf into the favour of his countrymen, that they inveſted him with ſovereign power. Pope Pius V. conferred the title of *grand duke* on Coſmo de Medicis anno 1570, in whoſe family the duchy continued until the death of Gaſton de Medicis, who died anno 1737. The duchy was then transferred to the duke of Lorrain, afterwards the emperor Francis I. in lieu of the duchy of Lorrain, which, by the peace of 1736, was given to King Staniſlaus during his life, and then was to be annexed to France. Leopold, the ſecond ſon of Francis I. and afterwards emperor of Germany, ſucceeded to this duchy. It is now enjoyed by Leopold's ſecond ſon, brother to the preſent emperor of Germany, Francis II. The grand duke's annual revenues are computed at about 500,000l. ſterling, ariſing chiefly from the tenths of all eſtates that are ſold or alienated, and the ground-rents of the houſes in Leghorn, and the duties on almoſt all manner of proviſions. Tuſcany now forms part of the kingdom of Italy ſubject to France.

TUSK, or TORSK. See GADUS, ICHTHYOLOGY *Index*.

TUSSILAGO, COLT'S-FOOT; a genus of plants belonging to the claſs of ſyngeneſia; and in the natural ſyſtem ranging under the 49th order, *Compoſitæ*. See BOTANY *Index*.

TUTENAG, an alloy of zinc. See CHEMISTRY *Index*.

TUTOR, in the civil law, is one choſen to look to the perſons and eſtate of children left by their fathers and mothers in their minority. The different kinds of *tutory* eſtabliſhed among the Romans, and the powers and duties of tutors, are deſcribed in *Inſt. Leg.* 1. tom. xiii. ſect. 1. and 2. to which the reader is referred. See alſo the article GUARDIAN.—For the nature and effects of tutory in the Scotch law, which is founded on that of the Romans, ſee *Scots LAW*, Part III. Sect. 7.

TUTOR is alſo uſed in the Engliſh univerſities for a member of ſome college or hall, who takes on him the inſtruction of young ſtudents in the arts and faculties.

TUTTY, an impure ore of zinc, employed as an unguent and abſorbent. See MATERIA MEDICA *Index*.

TWEED, a river of Scotland, which riſes on the confines of Clydeſdale, and running eaſtward through Tweedale, and dividing the ſhire of Merſe from Teviotdale and Northumberland, falls into the German ſea at Berwick. It abounds with ſalmon. See BERWICK.

TWEEDALE, or PEEBLES, a county in the ſouth of Scotland. See PEEBLES-SHIRE.

TWELFTH-DAY, the feſtival of the Epiphany, or the manifeſtation of Chriſt to the Gentiles; ſo called, as being the twelfth day, excluſive, from the nativity or Chriſtmas-day.

TWILIGHT, that light, whether in the morning before ſunriſe, or in the evening after ſunſet, ſuppoſed to begin and end when the leaſt ſtars that can be ſeen by the naked eye ceaſe or begin to appear.

TWINKLING *of the* STARS. See OPTICS, N° 21.

TWINS, two young ones delivered at a birth, by an animal which ordinarily brings forth but one.

TWITE. See FRINGILLA, ORNITHOLOGY *Index*.

TYGER, or TIGER. See FELIS, MAMMALIA *Index*.

TYLE, or TILE, in building, a thin laminated brick uſed on the roofs of houſes.

TYMPAN, among printers, a double frame belonging to the preſs, covered with parchment, on which the blank ſheets are laid in order to be printed off. See *PRINTING-Preſs*.

TYMPANUM, in *Mechanics*, a kind of wheel placed round an axis or cylindrical beam, on the top of which are two levers or fixed ſtaves for the more eaſily turning the axis in order to raiſe a weight required.

TYMPANUM, in *Anatomy*. See ANATOMY, N° 141.

TYMPANY, or TYMPANITES, in *Medicine*. See MEDICINE, N° 337, and SURGERY *Index*.

TYNDALE, WILLIAM, a zealous Engliſh reformer, and memorable for having made the firſt Engliſh verſion of the Bible, was born on the borders of Wales ſome time before 1500. He was of Magdalene-hall in Oxford, where he diſtinguiſhed himſelf by imbibing early the doctrines of Luther, and by as zealouſly propagating them. Afterwards he removed to Cambridge, and from thence went to live with a gentleman in Glouceſterſhire in the capacity of tutor to his children.—While he continued there, he ſhowed himſelf ſo furious for Luther, and ſo inveterate to the pope, that he was forced, merely for the ſecurity of his perſon, to leave the place. He next endeavoured to get into the ſervice of Tonſtall biſhop of Durham, but did not ſucceed. His zeal for Lutheraniſm made him deſirous to tranſlate the New Teſtament into Engliſh; and as this could not ſafely be done in England, he went into Germany, where, ſetting about the work, he finiſhed it in 1527. He then began with the Old Teſtament, and finiſhed the five books of Moſes, prefixing diſcourſes to each book, as he had done to thoſe of the New Teſtament. At his firſt going over into Germany, he went into Saxony, and had much conference with Luther; and then returning to the Netherlands, made his abode chiefly at Antwerp. During his peregrinations from one country to another, he ſuffered ſhipwreck upon the coaſt of Holland, and loſt all his books and papers. His tranſlations of the Scriptures being in the mean time ſent to England, made a great noiſe there; and, in the opinion of the clergy, did ſo much miſchief, that a royal proclamation was iſſued, prohibiting the buying or reading them. But the clergy were not ſatisfied with this, they knew Tyndale capable of doing infinite harm, and therefore thought of nothing leſs than removing him out of the way. For this purpoſe one Philips was ſent over to Antwerp, who inſinuated himſelf into his company, and under the pretext of friendſhip betrayed him into cuſtody. He was ſent to the caſtle of Filford, about 18 miles from Antwerp; and though the Engliſh merchants at Antwerp did what they could to procure his releaſe, and letters were alſo ſent from Lord Cromwell and others out of England, yet Philips beſtirred himſelf ſo heartily, that he was tried and condemned to die. He was firſt ſtrangled by the hands of the common hangman, and then burned near Filford caſtle, in 1536. While he was tying to the ſtake, he cried with a fervent and loud voice, "Lord, open the king of England's eyes."

TYPE (τυπος), an impreſſion, image, or repreſentation of ſome model, which is termed the *antitype*. In this ſenſe the word occurs often in the writings of divines, who employ it to denote that prefiguration of the great events of man's redemption which they have found or fancied in the principal tranſactions recorded in the Old Teſtament.

TYPE, among letter-founders and printers, the ſame with letter. See LETTER.

TYPE is alſo uſed to denote the order obſerved in the intenſion and remiſſion of fevers, pulſes, &c.

TYPHA, CAT'S-TAIL; a genus of plants belonging to the claſs of monœcia, and in the natural ſyſtem ranging under the 3d order, *Calamariæ*. See BOTANY *Index*.

TYPHON. See WHIRLWIND.

TYPHON, the devil of the ancient Egyptians. See POLYTHEISM, N° 29.

TYPOGRAPHY, the art of printing. See PRINTING.

TYRANT, among the ancients, denoted ſimply a king or monarch; but the ill uſe which ſeveral perſons inveſted with that ſacred character made of it, has altered the import of the word; and tyrant now conveys the idea of an unjuſt or cruel prince, who rules in a more deſpotic manner than the laws allow.

TYRE, formerly a celebrated city of Aſia, on the coaſt of Syria, ſituated under the 54th degree of eaſt longitude, and 32d of north latitude. It was built, according to ſome writers, 2760 years before the Chriſtian era. There were two cities of that name; the one called *Palætyrus*, ſituated on the continent; and the other the city of *Tyre*, built on an iſland about half a mile from the ſhore. It was about 19 miles in circumference, including Palætyrus; the town on the iſland was about four miles round. The buildings of Tyre were very magnificent; the walls were 150 feet high, and broad in proportion. This city was at one period the moſt famous commercial city in the world. Of its commercial tranſactions, the moſt particular account that is to be found in any ancient writer has been given by the prophet Ezekiel, which at the ſame time conveys a magnificent idea of the extenſive power of that ſtate. It reſiſted Nebuchadnezzar king of Babylon for 13 years; at the end of which, wearied with fruitleſs efforts, the inhabitants reſolved to place the ſea between them and their enemy, and paſſed accordingly into the iſland. The new city ſtood out againſt Alexander the Great for ſeven months; and before he could take it, he was obliged to fill up the ſtrait which ſeparated the iſland from the continent. It was repaired afterwards by Adrian, and became the metropolis of the province. It afterwards fell into the hands of the Arabs; and after being taken by Baldwin II. king of Jeruſalem, it was deſtroyed by the ſultan of Egypt in 1289, and abandoned. An excellent account of its modern ſtate may be found in Volney's Travels, vol. ii. It now conſiſts of a ſmall village, compoſed of fiſhermen's huts, and containing about 50 or 60 poor families.

TYRIAN DYE. See MUREX, CONCHOLOGY *Index*.

TYRONE, a county of Ireland, in the province of Ulſter, 46 miles in length and 37 in breadth; bounded on the north by Londonderry, on the eaſt by Armagh and Lough-Neagh, on the ſouth by Fermanagh, and on the weſt by Donnegal. It is a rough and rugged country, but tolerably fruitful; contains 12,683 houſes, 30 pariſhes, 4 baronies, 4 boroughs, and formerly ſent 10 members to the Iriſh parliament. The principal town is Dungannon.

U, V.

U, or u, the 20th letter and 5th vowel of our alphabet, is formed in the voice by a round configuration of the lips, and a greater extruſion of the under one than in forming the letter o, and the tongue is alſo more cannulated. The ſound is ſhort in *curſt*, *muſt*, *tun*, *tub*; but is lengthened by a final *e*, as in *tune*, *tube*, &c. In ſome words it is rather acute than long; as in *brute*, *flute*, *lute*, &c. It is moſtly long in polyſyllables; as in *union*, *curious*, &c; but in ſome woids it is obſcure, as in *nature*, *venture*, &c. This letter in the form of V or v, is properly a conſonant, and as ſuch is placed before all the vowels; as in *vacant*, *venal*, *vibrate*, &c. Though the letters v and u had always two ſounds, they had only the form v till the beginning of the fourth century, when the other form was introduced, the inconvenience of expreſſing two different ſounds by the ſame letter having been obſerved long before. In numerals V ſtands for five; and with a daſh added at top, thus $\bar{V}$, it ſignifies 5000.

In abbreviations, amongſt the Romans, V. A. ſtood for *veterani aſſignati*; V. B. *viro bono*; V. B. A. *viri boni arbitratu*; V. B. F. *vir bonæ fidei*; V. C. *vir conſularis*; V. C. C. F. *vale, conjux chariſſime, feliciter*; V. D. D. *voto dedicatur*; V. G. *verbi gratia*; Vir. Ve. *virgo veſtalis*; VL. *videlicet*; V. N. *quinto nonarum*.

VACCINIUM, the WHORTLE-BERRY, or *Bilberry*, a genus of plants belonging to the claſs octandria, and arranged in the natural ſyſtem under the 18th order, *Bicornes*. See BOTANY *Index*.

VACUUM, in *Philoſophy*, denotes a ſpace devoid of all matter or body.

It has been greatly diſputed whether there be in nature a perfect vacuum, or ſpace void of all matter; but if bodies conſiſt of material ſolid atoms, it is evident that there muſt be vacuities, or motion would be impoſſible (ſee METAPHYSICS, N° 193.). We can even produce ſomething very near a vacuum in the receiver of an air-pump and in the Torricellian tube (ſee PNEUMATICS, *paſſim*).

VADIUM, a pledge in law, is either *vivum* or *mortuum*.

VADIUM Vivum, or *Living Pledge*, is when a man borrows a ſum (ſuppoſe 200l.) of another; and grants him an eſtate, as of 20l. per annum, to hold till the rents and profits ſhall repay the ſum ſo borrowed. This is an eſtate conditioned to be void as ſoon as ſuch ſum is raiſed. And in this caſe the land or pledge is ſaid to be living: it ſubſiſts, and ſurvives the debts; and, immediately on the diſcharge of that, reverts to the borrower.

VADIUM Mortuum, or *Dead Pledge*. See MORTGAGE.

VAGABOND, or VAGRANT, one who wanders illegally, without a ſettled habitation. Such perſons are cognizable by the laws. See IDLENESS.

VAGINA, properly ſignifies a ſheath or ſcabbard; and the term *vagina* is uſed in architecture for the part of a terminus, becauſe reſembling a ſheath out of which the ſtatue ſeems to iſſue.

VAGINA. See ANATOMY *Index*.

VAILLANT, JOHN FOY, a phyſician and great medaliſt, to whom, according to Voltaire, France was indebted for the ſcience of medals, and Louis XIV. for one half of his cabinet, was born at Beauvais in 1632. Through the means of the miniſter Colbert he travelled into Italy, Greece, Egypt, and Perſia, to collect medals for the royal cabinet; and returned with ſo many as made the king's cabinet ſuperior to any in Europe. In one of his voyages the ſhip was taken by an Algerine corſair. After a captivity of near five months he was permitted to return to France, and received at the ſame time 20 gold medals which had been taken from him. He embarked in a veſſel bound for Marſeilles, and was carried on with a favourable wind for two days, when another corſair appeared, which, in ſpite of all the ſail they could make, bore down upon them within the reach of cannon ſhot. Mr Vaillant, dreading the miſeries of a freſh ſlavery, reſolved, however, to ſecure the medals which he had received at Algiers, and therefore ſwallowed them. But a ſudden turn of the wind freed them from this adverſary, and caſt them upon the coaſts of Catalonia, where, after expecting to run aground every moment, they at length fell among the ſands at the mouth of the Rhone. Mr Vaillant got to ſhore in a ſkiff, but felt himſelf extremely incommoded with the medals he had ſwallowed, which might weigh altogether five or ſix ounces, and therefore did not paſs like Scarborough waters. He had recourſe to a couple of phyſicians; who were a little puzzled with the ſingularity of his caſe; however, nature relieved him from time to time, and he found himſelf in poſſeſſion of the greateſt part of his treaſure when he got to Lyons. Among his collection was an Otho, valuable for its rarity.—He was much careſſed on his return; and when Louis XIV. gave a new form to the academy of inſcriptions in 1701, Mr Vaillant was firſt made aſſociate, and then penſionary. He wrote ſeveral works relating to ancient coins, and died in 1706.

VAIR, or VAIRE, a kind of fur, formerly uſed for lining the garments of great men and knights of renown. It is repreſented in engraving by the figures of little bells reverſed, ranged in a line. See HERALDRY, Chap. II. Sect. 2.

VAIRY, in *Heraldry*, expreſſes a coat, or the bearings of a coat, when charged or chequered with vairs.

VALAIS, a valley in Swiſſerland, which extends from the ſource of the river Rhone to the lake of Geneva. It is near 100 miles in length, but of unequal breadth. It is bounded on the north by the Alps, which ſeparate it from the cantons of Berne and Uri, on the eaſt by the mountains of Forche, on the ſouth by the duchy of Milan and the Val d'Aoſte, and on the weſt by Savoy and the republic of Geneva. The inhabitants profeſs the Roman Catholic religion, and are ſubject to the ſwelling of the throat called *bronchocele*; and idiots are ſaid to abound among them more than in any other place of the globe. They are naturally hardy, enterpriſing, and good-natured. Valais is ſurrounded on all ſides by very high mountains, moſt of which are covered with perpetual ſnow. The ſoil is fertile in corn, wine, and fruits. The muſcat-wine, which is produced here is excellent, and well known all over Europe. This country comprehends 55 large pariſhes, with one biſhop. The religion is the Roman Catholic.

VALANTIA, a genus of plants belonging to the claſs polygamia, and in the natural ſyſtem arranged under the 41ſt order, *aſperifoliæ*. See BOTANY *Index*.

VALENCIA, a province of Spain, which has the title of a kingdom; and is bounded on the eaſt and ſouth by the Mediterranean ſea, on the north by Catalonia and Arragon, and on the weſt by New Caſtile and the kingdom of Murcia. It is about 165 miles in length, and 63 in breadth. It is one of the moſt populous and agreeable parts of Spain, enjoying almoſt a perpetual ſpring. The great number of rivers wherewith it is watered renders it extremely fertile, particularly in fruits and wine. There are very rugged mountains in it, which contain mines of alum and other minerals.

VALENCIA, a city of Spain, and capital of the kingdom of the ſame name. It contains about 12,000 houſes, beſides thoſe of the ſuburbs and the ſummer-houſes round it. It has an univerſity, and an archbiſhop's ſee; and was taken from the Moors by the Chriſtians in the 13th century. The town is handſome, and adorned with very fine ſtructures. It is not very ſtrong, though there are ſome baſtions along the ſides of the walls. They have manufactures in wool and ſilk, which bring in great ſums to the inhabitants. It is ſeated on the river Guadalaviar, over which there are five handſome bridges; and it is about three miles from the ſea, where there is a harbour, 110 miles north of Murcia, and 165 eaſt by ſouth of Madrid. This city ſurrendered to the earl of Peterborough in the year 1705; but it was loſt again in 1707. W. Long. 0. 10. N. Lat. 39. 23.

VALENCIENNES, an ancient, ſtrong, and conſiderable city of France, in the department of the North and late province of Hainault, containing about 20,000 ſouls. The Scheldt divides it into two parts. It is a very important place: the citadel and fortifications, the work of Vauban, were conſtructed by order of Louis XIV. who took this town from the Spaniards. It was confirmed to him by the treaty of Nimeguen, in 1678. In 1793, it ſurrendered to the allies after a ſevere ſiege, but was afterwards abandoned; and is now in poſſeſſion of the French. Beſides lace, this city is noted for manufactories of woollen ſtuffs and very fine linens. It is 20 miles weſt-ſouth-weſt of Mons, 17 north-eaſt of Cambray, and 120 north-eaſt by north of Paris. E. Long. 3. 37. N. Lat. 50. 21.

VALENS, FLAVIUS, emperor of the Eaſt, a great patron of the Arians. Killed by the Goths in the year 379. See CONSTANTINOPLE, N° 76.

VALENTINIAN I. emperor of the Weſt, a renowned warrior, but a tyrant over his ſubjects. See ROME, N° 523.

VALENTINIAN II. emperor of the Weſt, a prince celebrated for his virtues, and above all for his moderation; yet a conſpiracy was formed againſt him by Arbogaſtes,

bogaſtes, the commander in chief of his armies; and he was ſtrangled in the year 392. See Rome, N° 536.

VALENTINIANS, in church hiſtory, a ſect of Chriſtian heretics, who ſprung up in the ſecond century, and were ſo called from their leader Valentinus.

The Valentinians were only a branch of the Gnoſtics, who realized or perſonified the Platonic ideas concerning the Deity, whom they called *Pleroma* or *Plenitude.* Their ſyſtem was this: the firſt principle is Bythos, i. e. Depth, which remained many ages unknown, having with it Ennoe or Thought, and Sige or Silence; from theſe ſprung the Nous or Intelligence, which is the only ſon, equal to and alone capable of comprehending the Bythos; the ſiſter of Nous they called *Aletheia* or *Truth;* and theſe conſtituted the firſt quaternity of æons, which were the ſource and original of all the reſt: for Nous and Aletheia produced the World and Life; and from theſe two proceeded Man and the Church. But beſides theſe 8 principal æons, there were 22 more; the laſt of which, called *Sophia*, being deſirous to arrive at the knowledge of Bythos, gave herſelf a great deal of uneaſineſs, which created in her Anger and Fear, of which was born Matter. But the Horos or Bounder ſtopped her, preſerved her in the Pleroma, and reſtored her to Perfection. Sophia then produced the Chriſt and the Holy Spirit, which brought the æons to their laſt perfection, and made every one of them contribute their utmoſt to form the Saviour. Her Enthymeſe, or Thought, dwelling near the Pleroma, perfected by the Chriſt, produced every thing that is in the world by its divers paſſions. The Chriſt ſent into it the Saviour, accompanied with angels, who delivered it from its paſſions, without annihilating it: from thence was formed corporeal matter. And in this manner did they romance concerning God, nature, and the myſteries of the Chriſtian religion.

VALERIAN, or Valerianus, *Publius Licinius*, emperor of Rome, remarkable for his captivity and cruel treatment by Sapor I. king of Perſia. See Rome, N° 491.

VALERIANA, a genus of plants belonging to the claſs triandria, and in the natural ſyſtem arranged under the 48th order, *aggregatæ.* See Botany and Materia Medica *Index*.

VALERIUS Maximus, a Latin hiſtorian, ſprung from the families of the Valerii and Fabii, which made him take the name of *Valerius Maximus.* He ſtudied polite literature, and afterwards followed Sextus Pompey to the wars. At his return he compoſed an account of the actions and remarkable ſayings of the Romans and other great men; and dedicated that work to the emperor Tiberius. Many of the learned think that this is the ſame that is now extant, and bears the name of Valerius Maximus; but others maintain, that what we have now is only an abridgment of the work written by this celebrated hiſtorian, and that this abridgment was made by one Nepotian of Africa. However, this work is well written, and contains a great number of memorable actions performed by the Greeks and Romans that are worthy of being read.

VALET, a French term, uſed as a common name for all domeſtic men ſervants employed in the more ſervile offices, as grooms, footmen, coachmen, &c. But with us it is only uſed in the phraſe *valet de chambre*, which is a ſervant whoſe office is to dreſs and undreſs his maſter, &c.

VALETTA, a city of Malta, and capital of the iſland (ſee Malta, N° 26.). It is ſituated in E. Long. 14. 34. N. Lat. 35. 54.

VALETUDINARY, among medical writers, denotes a perſon of a weak and ſickly conſtitution, and frequently out of order.

VALID, in *Law*, an appellation given to acts, deeds, tranſactions, &c. which are clothed with all the formalities requiſite to their being put into execution, and to their being admitted in a court of juſtice.

VALLADOLID, an ancient, large, and handſome city of Spain, in Old Caſtile, and capital of a principality of the ſame name, with a biſhop's ſee and an univerſity. It is ſurrounded with ſtrong walls, embelliſhed with handſome buildings, large public ſquares, piazzas, and fountains; containing 11,000 houſes, with fine long and broad ſtreets, and high houſes, adorned with balconies. There is a ſquare in the middle of the city, ſurrounded with handſome brick houſes, having under them piazzas, where people may walk dry in all weathers. Within theſe piazzas merchants and tradeſmen keep their ſhops. All the houſes are of the ſame height, being four ſtories; and there are balconies at every window, of gilt iron. In the whole there are 70 monaſteries and nunneries; the fineſt of which is that of the Dominicans, remarkable for its church, which is one of the moſt magnificent in the city. The kings reſided a long while at this place; and the royal palace, which ſtill remains, is of very large extent, though but two ſtories high; within are fine paintings of various kinds, and at one of the corners a curious clock, made in the ſame manner as that of Straſburg. The environs of the city are a fine plain, covered with gardens, orchards, vineyards, and meadows. It is ſeated on the rivers Eſcurva and Peſuerga, in W. Long. 4. 25. N. Lat. 41. 50.

VALUE, in *Commerce*, denotes the price or worth of any thing.

VALVE, in *Hydraulics*, *Pneumatics*, &c. is a kind of lid or cover of a tube or veſſel ſo contrived as to open one way, but which, the more forcibly it is preſſed the other way, the cloſer it ſhuts the aperture; ſo that it either admits the entrance of a fluid into the tube or veſſel, and prevents its return; or admits its eſcape, and prevents its re-entrance.

Valve, in *Anatomy*, a thin membrane applied on ſeveral cavities and veſſels of the body, to afford a paſſage to certain humours going one way, and prevent their reflux towards the place from whence they came.

VAMPYRE, a ſpecies of bat. See Vespertilio, Mammalia *Index*.

VAN, a term derived from the French *avant* or *avaunt*, ſignifying before or foremoſt of any thing: thus we ſay, the van-guard of the army, &c.

VANBRUGH, Sir John, a celebrated Engliſh dramatic writer and architect, was deſcended of a family in Cheſhire which came from France, though by his name he appears to have been originally of Dutch extraction. He was born about the middle of the reign of Charles II. and received a liberal education. His firſt comedy, called the Relapſe or Virtue in Danger, was acted in the year 1697 with great applauſe; which gave him ſuch encouragement,

encouragement, that he wrote eleven more comedies. He was the friend of Mr Congreve, whoſe genius was naturally turned for dramatic performances; and theſe two gave new life to the Engliſh ſtage, and reſtored its ſinking reputation. Sir John was alſo eſteemed an able architect. Under his direction was raiſed Blenheim-houſe in Oxfordſhire. He died in 1726.

VANDELLIA, a genus of plants belonging to the claſs didynamia. See BOTANY *Index*.

VAN-DIEMEN'S LAND. See DIEMEN.

VANDYCK, SIR ANTHONY, a celebrated painter, was born at Antwerp in the year 1599. After giving early proofs of his genius, he became the diſciple of the illuſtrious Rubens. In the church of the Auguſtines at Antwerp, at the high altar, is a celebrated picture of Rubens, repreſenting, in one part, the Virgin Mary ſitting with the child Jeſus in her lap, and in another part ſeveral ſaints, male and female, ſtanding. The breaſt of one of theſe, St Sebaſtian, is ſaid to have been painted by Vandyck when he was only a diſciple of Rubens. This great maſter being engaged one day abroad, his diſciples went into his painting-room, where, after having been ſome time employed in admiring his works, they began to play or romp in ſuch a manner, that the breaſt of St Sebaſtian, which was not yet dry, was bruſhed away by a hat thrown at random. This accident put an end to their play: they were very anxious to reſtore it, fearing that if Rubens diſcovered it they ſhould all be diſcarded. At length it was agreed that Anthony ſhould undertake to mend the ſaint's breaſt. In ſhort, taking his maſter's pallet and bruſhes, he ſucceeded ſo well that his companions imagined Rubens would overlook it. They were miſtaken; for Rubens at his return knew immediately that ſome one had touched upon his performance: calling his diſciples, he aſked them why any one had dared to meddle with his painting? They were ſome time doubtful whether they ſhould confeſs or deny the fact. Threats at length prevailed: they owned that Vandyck had thrown his hat upon it. Upon this, cloſeting Vandyck, inſtead of chiding him, he told him, that "it was proper and even neceſſary for him to travel into Italy, the only ſchool that produced excellent painters." By this advice, and with the aſſiſtance of his maſter, he ſet out for Italy, about the year 1621, being then about 21 or 22 years of age. Having ſtaid a ſhort time at Rome, he removed to Venice, where he attained the beautiful colouring of Titian, Paul Veroneſe, and the Venetian ſchool.

After a few years he returned to Flanders, with ſo noble, ſo eaſy, and natural a manner of painting, that Titian himſelf was hardly his ſuperior: and no other maſter could equal him in portraits. Soon after his return, he accidentally met with D. Teniers, who accoſted him with great politeneſs, and aſked him whether he had much buſineſs ſince he came from Rome? "What buſineſs, think you, can I have had time to do (replied Vandyck)? I am only juſt arrived here. Would you believe, that I offered to draw that fat brewer's picture who juſt paſſed by us for two piſtoles, and that the looby laughed in my face, ſaying it was too dear? I aſſure you, that if the cards do not turn up better, I ſhall make no long ſtay at Bruſſels." Soon after this, he painted thoſe two famous pictures, the Nativity and a dying Chriſt; the firſt in the pariſh-church, the ſecond in that of the Capuchins, at Termond.

Vandyck, finding he could not make a fortune in his own country, took a reſolution of going over into England. Accordingly he borrowed ſome guineas of Teniers, and ſet out, furniſhed with letters of recommendation. His ſuperior genius ſoon brought him into great reputation; and above all, he excelled in portraits, which he drew with an inconceivable facility, and for which he charged a very high price, according to the inſtructions which had been given him on that head. It is affirmed, that for ſome of them he received 400 guineas apiece. He ſoon found himſelf loaded with honours and riches; and as he had a noble and generous heart, he lived equal to his fortune. He married a daughter of the lord Ruthven, earl of Gowry; and, though ſhe had but little fortune, maintained her in a ſtyle ſuitable to her birth. He generally kept a magnificent equipage, and a numerous retinue. He died in 1641, at the age of 42, leaving property, it is ſaid, to the amount of 40,000l. ſterling.

VANE, a thin ſlip of bunting hung to the maſt-head, or ſome other conſpicuous place in the ſhip, to ſhow the direction of the wind. It is commonly ſewed upon a wooden frame called the *ſtock*, which contains two holes whereby to ſlip over the ſpindle, upon which it turns about as the wind changes.

VANILLA, or VANILLO. See EPIDENDRUM, BOTANY *Index*.

VAPOUR, in *Philoſophy*, the particles of bodies rarefied by heat, and thus rendered ſpecifically lighter than the atmoſphere, in which they riſe. See EVAPORATION, and HEAT, CHEMISTRY *Index*.

VAPOURS, in *Medicine*, otherwiſe called *hypochondriaſis* or *ſpleen*. See MEDICINE, N° 276 and 321.

VAPOUR-Bath, in *Chemiſtry*, a term applied to a chemiſt's bath or heat, in which a body is placed ſo as to receive the fumes of boiling water.

We alſo uſe the term *vapour-bath*, when a ſick perſon is made to receive the vapours ariſing from ſome liquid matter placed over a fire. Many contrivances have been propoſed for this purpoſe; and their expediency and utility are beſt known to thoſe who are converſant in this buſineſs. A late writer has ſuggeſted a new conſtruction of vapour baths; and the whole apparatus is reduced to a tin-boiler, tin pipes wrapped in flannel, and a deal box with a cotton cover, for the reception of the body and circulation of the vapour.

VARI, in *Medicine*, little, hard, and ruddy tumors, which frequently infeſt the faces of young perſons of a hot temperament of body.

VARIATION *of the Compaſs*, is the deviation of the magnetic or mariner's needle from the meridian or true north and ſouth line. On the continent it is called the *declination* of the magnetic needle; and this is a better term, for reaſons which will appear by and by.

We have given the general facts relating to magnetic variation under the article MAGNETISM, N° 19.; and under the articles COMPASS, and *Azimuth* COMPASS, we have noticed the methods of aſcertaining the variation at any particular time or place. We ſhall here only give a ſhort hiſtorical account of the progreſſive diſcoveries reſpecting magnetic variation, and notice the

the explanations that have been offered to account for this phenomenon.

About the time that the polarity of the magnet was firſt obſerved in Europe, the magnetic direction, both in Europe and in China, was nearly in the plane of the meridian. It was therefore an ineſtimable preſent to the mariner, giving him a ſure direction in his courſe through the pathleſs ocean. But by the time that the European navigators had engaged in their adventurous voyages to far diſtant ſhores, the deviation of the needle from the meridian was very ſenſible even in Europe. The ſon of Columbus poſitively ſays, that it was obſerved by his father in his firſt voyage to America, and made his companions ſo anxious leſt they ſhould not find the way back again to their own country, that they mutinied and refuſed to proceed. It is certain that Gonzales Oviedo and Sebaſtian Cabot obſerved it in their voyages. Indeed it could not poſſibly eſcape them; for in ſome parts of their ſeveral tracks the needle deviated above 25° from the meridian; and the rudeſt dead reckoning, made on the ſuppoſition of the needle pointing due north and ſouth, muſt have thrown the navigators into the utmoſt confuſion. We know that ſpherical trigonometry was at that time abundantly familiar to the mathematicians of Europe, and that no perſon pretended to take the command of a ſhip bound to a diſtant port that was not much more informed in this ſcience than moſt maſters of ſhips are at preſent. The deviation of the compaſs, however, was not generally allowed by mathematicians, who had not yet become ſenſible of the neceſſity of quitting the Ariſtotelian trammels, and inveſtigating nature by experiments. They choſe rather to charge the navigators with inaccuracy in their obſervations than the ſchoolmen with errors in principles. Pedro de Medina at Valladolid, in his *Arte de Naviggar*, publiſhed in 1545, denies the variation of the compaſs. But the concurring reports of the commanders of ſhips on diſtant voyages, in a few years, obliged the landſmen in their cloſets to give up the point; and Martin Cortez, in a treatiſe of navigation, printed at Seville before 1556, treats it as a thing completely eſtabliſhed, and gives rules and inſtruments for diſcovering its quantity. About the year 1580 Norman publiſhed his diſcovery of the *dip* of the needle, and ſpeaks largely of the horizontal deviation from the plane of the meridian, and attributes it to the attraction of a point, not in the heavens, but in the earth, and deſcribes methods by which he hoped to find its place. To the third, and all the ſubſequent editions of Norman's book (called the *New Attractive*), was ſubjoined a diſſertation by Mr Burroughs, comptroller of the navy, on the variation of the compaſs, in which are recorded the quantity of this deviation in many places; and he laments the obſtacle which it cauſes to navigation by its total uncertainty previous to obſervation. The author indeed offers a rule for computing it *à priori*, founded on ſome conjecture as to its cauſe; but, with the modeſty and candour of a gentleman, acknowledges that this is but a gueſs, and intreats all navigators to be aſſiduous in their obſervations, and ready in communicating them to the public. Accordingly obſervations were liberally contributed from time to time, and were publiſhed in the ſubſequent treatiſes on navigation.

But in 1635 the mariners were thrown into a new and great perplexity, by the publication of a *Diſcourſe Mathematical on the Variation of the Magnetical Needle*, by Mr Henry Gillebrand, Greſham profeſſor of aſtronomy. He had compared the variations obſerved at London by Burroughs, Gunter, and himſelf, and found that the north end of the mariner's needle was gradually drawing more to the weſtward. For Norman and Burroughs had obſerved it to point about 11½ degrees to the eaſt of north in 1580; Gunter found its deviation only 6¼ in 1622, and he himſelf had obſerved only 4° in 1634; and it has been found to deviate more and more to the weſtward ever ſince, as may be ſeen from the tables given under MAGNETISM.

Mr Bond, teacher of mathematics in London, and employed to edit and improve the impreſſions of the popular treatiſes of navigation, about 1650, declared, in a work called the "Seaman's Kalendar," that he had diſcovered the true progreſs of the deviation of the compaſs; and publiſhed in another work, called the "Longitude Found," a table of the variation for 50 years. This was, however a gratuitous prognoſtication, not founded on any well-grounded principles; and though it agreed very well with the obſervations made in London, which ſhowed a gradual motion to the weſtward at the rate of —.12′ annually, by no means agreed with the obſervations made in other places. See Phil. Tranſ. 1668.

But this news ſoon loſt its credit: for the inconſiſtency with obſervation appeared more and more every day, and all were anxious to diſcover ſome general rule, by which a near gueſs at leaſt might be made as to the direction of the needle in the moſt frequented ſeas. Halley recommended the matter in the moſt earneſt manner to the attention of government; and, after much unwearied ſolicitation, obtained a ſhip to be ſent on a voyage of diſcovery for this purpoſe. He got the command of this ſhip, in which he repeatedly traverſed the Atlantic ocean, and went as far as the 50th degree of ſouthern latitude. See his very curious ſpeculations on this ſubject in the Phil. Tranſ. 1683 and 1692.

After he had collected a prodigious number of obſervations made by others, and compared them with his own, he publiſhed in 1700 a ſynoptical account of them in a very ingenious form of a ſea chart, where the ocean was croſſed by a number of lines paſſing through thoſe planes where the compaſs had the ſame deviation. Thus, in every point of one line there was no variation in 1700; in every point of another line the compaſs had 20° of eaſt variation; and in every point of a third line it had 20° of weſt variation. Theſe lines have ſince been called *Halleyan lines*, or curves. This chart was received with univerſal applauſe, and was undoubtedly one of the moſt valuable preſents that ſcience has made to the arts.

The polarity of the magnetic needle, and a general though intricate connection between its poſitions in all parts of the world, naturally makes the philoſopher ſpeculate about its cauſe. We ſee that Cortez aſcribed it to the attraction of an eccentric point, and that Bond thought that this point was placed not in the heavens, but in the earth. This notion made the baſis of the famous Theory of Magnetiſm of Dr Gilbert of Colcheſter. See MAGNETISM, N° 71.

Gilbert's theory may be underſtood from the following general propoſition.

Let NS (fig. 1.) be a magnet, of which N is the north

Plate DXL. Fig. 1.

north and S the ſouth pole: Let *n s* be any oblong piece of iron, poiſed on a point *c* like a compaſs needle. It will arrange itſelf in a poſition *n c s* preciſely the ſame with that which would be aſſumed by a compaſs needle of the ſame ſize and ſhape, having *n* for its north and *s* its ſouth pole. And while the piece of iron remains in this poſition, it will be in all reſpects a magnet ſimilar to the real compaſs needle. The pole *n* will attract the ſouth pole of a ſmall magnetiſed needle, and repel its north pole. If a paper be held over *n s*, and fine iron-filings be ſtrewed on it, they will arrange themſelves into curves iſſuing from one of its ends and terminating at the other, in the ſame manner as they will do when ſtrewed on a paper held over a real compaſs needle. But this magnetiſm is quite temporary; for if the piece of iron *n s* be turned the other way, placing *n* where *s* now is, it will remain there, and will exhibit the ſame phenomena. We may here add, that if *n s* be almoſt infinitely ſmall in compariſon of NS, the line *n s* will be in ſuch a poſition that if *s a*, *s b*, be drawn parallel to N*c*, S*c*, we ſhall have *s a* to *s b*, as the force of the pole N to the force of the pole S. And this is the true cauſe of that curious diſpoſition of iron-filings when ſtrewed round a magnet. Each fragment becomes a momentary magnet, and arranges itſelf in the true magnetic direction, and when ſo arranged, attracts the two adjoining fragments, and co-operates with the forces, which alſo arrange them. We throw this out to the ingenious mechanician as the foundation of a *complete* theory of the magnetical phenomena. When the filings are infinitely fine, the curves N*c*S have this property, that, drawing the tangent *n c s*, we always have $sa : sb =$ force of N : force of S; and thus we may approximate at pleaſure to the law of magnetic attraction and repulſion. The theory, of which an outline is given under MAGNETISM, is founded on this principle, and applies with ſucceſs to every phenomenon yet obſerved.

Now, to apply this theory to the point in hand.—Let *n s* (fig. 2.) be a ſmall compaſs needle, of which *n* is the north and *s* the ſouth pole: let this needle be poiſed horizontally on the pin *c d*; and let *n' s'* be the poſition of the *dipping needle*. Take any long bar of common iron, and hold it upright, or nearly ſo, as repreſented by AB. The lower end B will repel the pole *n* and will attract the pole *s*, thus exhibiting the properties of a north pole of the bar AB. Keeping B in its place, turn the bar round B' as a centre, till it come into the poſition A'B' nearly parallel to *n' s'*. You will obſerve the compaſs needle *n s* attract the end B' with either pole *n* or *s*, when B'A' is in the poſition B'α perpendicular to the direction *n' s'* of the dipping needle: and when the bar has come into the poſition B' A', the upper end B' will ſhow itſelf to be a ſouth pole by attracting *n* and repelling *s*. This beautiful experiment was exhibited to the Royal Society in 1673 by Mrs Hindſhaw.

From this it appears, that the great magnet in the earth induces a momentary magnetiſm on ſoft iron preciſely as a common magnet would do. Therefore (ſays Dr Gilbert) it induces permanent magnetiſm on magnetiſable ores of iron, ſuch as loadſtones, in the ſame manner as a great loadſtone would do; and it affects the magnetiſm already imparted to a piece of tempered ſteel preciſely as any other great magnet would. Therefore the needle of the mariner's compaſs in every part of the world arranges itſelf in the magnetic direction, ſo that if poiſed as a dipping needle ſhould be, it will be a tangent to one of the curves N*c*S of fig. 1. The horizontal needle being ſo poiſed as to be capable of playing only in a horizontal plane, will only arrange itſelf *in the plane* of the triangle N*c*S. That end of it which has the ſame magnetiſm with the ſouth pole S of the great magnet included in the earth will be turned towards its north pole N. Therefore what we call the north pole of a needle or magnet really has the magnetiſm of the ſouth pole of the great primitive magnet. If the line NS be called the axis, and N and S the poles of this great magnet, the plane of any one of theſe curves N*c*S will cut the earth's ſurface in the circumference of a circle, great or ſmall according as the plane does or does not paſs through the centre of the earth.

Dr Halley's firſt thought was, that the north pole of the great magnet or loadſtone which was included in the bowels of the earth was not far from Baffin's bay, and its ſouth pole in the Indian ocean ſouth-weſt from New Zealand. But he could not find any poſitions of theſe two poles which would give the needle that particular poſition which it was obſerved to aſſume in different parts of the world; and he concluded that the great terreſtrial loadſtone had four irregular poles (a thing not unfrequent in natural loadſtones, and eaſily producible at pleaſure), two of which are ſtronger and two weaker. When the compaſs is at a great diſtance from the two north poles, it is affected ſo as to be directed nearly in a plane paſſing through the ſtrongeſt. But if we make it approach much more to the weakeſt, the greater vicinity will compenſate for the ſmaller abſolute force of the weak pole, and occaſion conſiderable irregularities. The appearances are favourable to this opinion. If this be the real conſtitution of the great magnet, it is almoſt a deſperate taſk to aſcertain by computation what will be the poſition of the needle. Halley ſeems to have deſpaired: for he was both an elegant and a moſt expert mathematician, and it would have coſt *him* little trouble to aſcertain the places of two poles only, and the direction which theſe would have given to the needle. But to ſay what would be its poſition when acted on by four poles, it was neceſſary to know the law by which the magnetic action varied by a variation of diſtance; and even then, the computation would have been exceedingly difficult.

In order to account for the change of variation, Dr Halley ſuppoſes this internal magnet not to adhere to the external ſhell which we inhabit, but to form a nucleus or kernel detached from it on all ſides, and to be ſo poiſed as to revolve freely round an axis, the poſition of which he hopes to diſcover by obſervation of the compaſs. Dr Halley imagined that the nucleus revolved from eaſt to weſt round the ſame axis with the earth. Thus the poles of the magnet would change their poſitions relatively to the earth's ſurface, and this would change the direction of the compaſs needle.

The great Euler, whoſe delight it was always to engage in the moſt difficult mathematical reſearches and computations, undertook to aſcertain the poſition of the needle in every part of the earth. His diſſertation on this ſubject is to be ſeen in the 13th volume of the Memoirs of the Royal Academy of Berlin, and is exceedingly beautiful, abounding in thoſe analytical *tours d'adreſſe* in which he ſurpaſſed all the world. He has reduced the computation to a wonderful ſimplicity.

He found, however, that four poles would engage him in an analyſis which would be exceſſively intricate, and has contented himſelf with computing for two only; obſerving that this ſuppoſition agrees ſo well with obſervation, that it is highly probable that this is the real conſtitution of the terreſtrial magnet, and that the coincidence would have been perfect if he had hit on the due poſitions of the two poles. He places one of them in lat. 76° north, and long. 96° weſt from Teneriffe. The ſouth pole is placed in lat. 58° ſouth, and long. 158° weſt from Teneriffe. Theſe are their ſituations for 1757.—Mr Euler has annexed to his diſſertation a chart of Halleyan curves ſuited to theſe aſſumptions, and fitted to the year 1757.

It muſt be acknowledged, that the *general* courſe of the variations according to this theory greatly reſembles the real ſtate of things; and we cannot but own ourſelves highly indebted to this great mathematician for having made ſo fine a firſt attempt. He has improved it very conſiderably in another diſſertation in the 22d volume of theſe memoirs. But there are ſtill ſuch great differences, that the theory is of no uſe to the navigator, and it only ſerves as an excellent model for a farther proſecution of the ſubject. Since that time another large variation chart has been publiſhed, fitted to a late period; but the public has not ſufficient information of the authorities or obſervations on which it is founded.

The great object in all theſe charts is to facilitate the diſcovery of a ſhip's longitude at ſea. For the lines of variation being drawn on the chart, and the variation and the latitude being obſerved at ſea, we have only to look on the chart for the interſection of the parallel of obſerved latitude and the Halleyan curve of obſerved variation. This interſection muſt be the place of the ſhip. This being the purpoſe, the Halleyan lines are of great ſervice; but they do not give us a ready conception of the direction of the needle. We have always to *imagine* a line drawn through the point, cutting the meridian in the angle correſponding to the Halleyan line. We ſhould learn the general magnetic affections of the globe much better if a number of magnetic meridians were drawn. Theſe are the interſections of the earth's ſurface with planes paſſing through the magnetical axis, cutting one another in angles of 5° or 10°. This would both ſhow us the places of the magnetic poles much more clearly, and would, in every place, ſhow us at once the direction of the needle. In all thoſe places where theſe magnetic curves touch the meridians, there is no variation; and the variation in every other place is the angle contained between theſe magnetic meridians and the true ones.

The program of a work of this kind has been publiſhed by a Mr Churchman, who appears to have engaged in the inveſtigation with great zeal and conſiderable opportunities. It is pretty certain that the north magnetic pole (or point, as Mr Churchman calls it) is not far removed from the ſtations given it by Halley and Euler; and there ſeems no doubt but that in the countries between Hudſon's bay and the weſtern coaſts of North America the needle will have every poſition with reſpect to the terreſtrial meridian, ſo that the north end of a compaſs needle will even point due ſouth in ſeveral places. Almoſt every thing that can be deſired in this inquiry would be obtained by a few *well-choſen* obſervations made in thoſe regions. It would be of immenſe advantage to have the *dips* aſcertained with great preciſion. Theſe would enable us to judge at what depth under the ſurface the pole is ſituated; for the well-informed mechanician, who will ſtudy ſeriouſly what we have ſaid about the magnetical curves, will ſee that a compaſs needle, when compared with the great terreſtrial magnet, is but as a particle of iron-filings compared to a very large artificial magnet. Therefore, from the poſition of the dipping needle, we may infer the place of the pole, if the law of magnetic action be given; and this law may be found by means of other experiments which we could point out. See MAGNETISM, N° 80, *et ſeq.*

Mr Churchman has adopted the opinion of only two poles. According to him, the north pole was (in 1800) in Lat. 58° N. and Long. 134° W. from Greenwich, very near Cape Fairweather; and the ſouth pole lies in Lat. 58° S. and Long. 165° E. from Greenwich. He alſo imagines that the north pole has moved to the eaſtward, on a parallel of latitude, about 65 ſince the beginning of the 19th century (from 1600), and concludes that it makes a revolution in 1096 years. The ſouthern pole has moved leſs, and completes its revolution in 2289 years. This motion he aſcribes to ſome influences which he calls *magnetic tides*, and which he ſeems to conſider as celeſtial. This he infers from the changes of variation. He announces a phyſical theory on this ſubject, which, he ſays, enables him to compute the variation with preciſion for any time paſt or to come; and he even gives the proceſs of trigonometrical computation illuſtrated by examples. But as this publication (entitled *The Magnetic Atlas*), publiſhed for the author, by Darton and Harvey, 1794) is only a program, he expreſſes himſelf obſcurely, and ſomewhat enigmatically, reſpecting his theory. He ſpeaks of the influence of one pole being greater than that of the other; and ſays, that in this caſe the magnetic equator, where the needle will be parallel to the axis, will not be in the middle between the poles. This is true of a common magnet. He muſt therefore abide by this ſuppoſition in its other conſequences. The magnetic meridians muſt be planes paſſing through this axis, and therefore muſt be circles on the ſurface of the earth. This is incompatible with the obſervations; nay, his charts are ſo in many places, particularly in the Pacific ocean, where the variations by his chart are three times greater than what has been obſerved.—His parallels of dip are ſtill more different from obſervation, and are incompatible with any phenomena that could be produced by a magnet having but two poles. His rules of computation are exceedingly exceptionable. He has in fact but one example, and that ſo particular, that the mode of computation will not apply to any other. This circumſtance is not taken notice of in the enunciation of his firſt problem; and the reader is made to imagine that he has got a rule for computing the variation, whereas all the rules of calculation are only running in a circle. The variation computed for the port of St Peter and Paul in Kamtſchatka, by the rule, is ten times greater than the truth.

For our own part, we have little hopes of this problem ever being ſubjected to accurate calculation. We believe,

believe, indeed, that there is a coſmical change going on in the earth, which will produce a progreſſive change in the variation of the needle; and we ſee none more likely than Dr Halley's motion. There is nothing repugnant to our knowledge of the univerſe in the ſuppoſition of a magnetic nucleus revolving within this earth; and it is very eaſy to conceive a very ſimple motion of revolution, which ſhall produce the very motion of the ſenſible poles for which Mr Churchman contends. We need only ſuppoſe that the magnetical axis of this nucleus is not its axis of revolution. It may not even biſect that axis; and this circumſtance will cauſe the two poles to have different degrees of motion in relation to the ſhell which ſurrounds it.

But this regular progreſs of the magnet within the earth may produce very irregular motions of the compaſs needle, by the intervention of a third body ſuſceptible of magnetiſm. The theory of which we have juſt given a hint comes here to our aſſiſtance. Suppoſe NS (fig. 3.) to repreſent the primitive magnet in the earth, and $n\,s$ to be a ſtratum of iron ore ſuſceptible of magnetiſm. Alſo let $n'\,s'$ be another ſmall maſs of a ſimilar ore; and let their ſituations and magnitudes be ſuch as is exhibited in the figure. The fact will be, that n will be the north pole and s the ſouth pole of the great ſtratum, and n' and s' will be the north and ſouth poles of the ſmall maſs or loadſtone. Any perſon may remove all doubts as to this, by making the experiment with a magnet NS, a piece of iron or ſoft tempered ſteel $n\,s$, and another piece $n'\,s'$. The well-informed and attentive reader will eaſily ſee, that by ſuch interventions every conceivable anomaly may be produced. While the great magnet makes a revolution in any direction, the needle will change its poſition gradually, and with a certain regularity; but it will depend entirely on the ſize, ſhape, and ſituation, of theſe intervening maſſes of magnetiſable iron ore, whether the change of variation of the compaſs ſhall be ſuch as the primitive magnet alone would have produced, or whether it ſhall be of a kind wholly different.

Now, that ſuch intervening diſturbances *may* exiſt, is paſt contradiction. We know that even on the film of earth which we inhabit, and with which only we are acquainted, there are extenſive ſtrata or otherwiſe diſpoſed maſſes of iron ores in a ſtate ſuſceptible of magnetiſm; and experiments made on bars of hard tempered ſteel, and on bits of ſuch ores, aſſure us that the magnetiſm is not induced on ſuch bodies in a moment, but propagated gradually along the maſs.—That ſuch diſturbances do actually exiſt, we have many relations. There are many inſtances on record of very extenſive magnetic rocks, which affect the needle to very conſiderable diſtances. The iſland of Elba in the Mediterranean is a very remarkable inſtance of this. The iſland of Cannay alſo, on the weſt of Scotland, has rocks which affect the needle at a great diſtance.

A ſimilar effect is obſerved near the Feroe iſlands in the North ſea; the compaſs has no determined direction when brought on ſhore. *Journ. de Sçavans*, 1679, p. 174.

In Hudſon's ſtraits, in latitude 63°, the needle has hardly any polarity. *Ellis's Voyage to Hudſon's Bay.*

Bouguer obſerved the ſame thing in Peru. Nay, we believe that almoſt all rocks, eſpecially of whin or trappe ſtone, contain iron in a proper ſtate.

All this refers only to the thin cruſt through which the human eye has occaſionally penetrated. Of what may be below we are ignorant; but when we ſee appearances which tally ſo remarkably with what would be the effects of great maſſes of magnetical bodies, modifying the general and regularly progreſſive action of a primitive magnet, whoſe exiſtence and motion is inconſiſtent with nothing that we know of this globe, this manner of accounting for the obſerved change of variation has all the probability that we can deſire. Nay, we apprehend that very conſiderable changes may be produced in the direction of the compaſs needle, even without the ſuppoſition of any internal motion. If the great magnet reſembles many loadſtones we are acquainted with, having more than two poles, we know that theſe poles will act on each other, and gradually change each other's force, and conſequently the direction of the compaſs. This proceſs, to be ſure, tends to a ſtate of things which will change no more.—But the period of human hiſtory, or of the hiſtory of the race of Adam, may make but a ſmall part of the hiſtory of this globe; and therefore this objection is of little force.

There can be no doubt of the operation of the general terreſtrial magnetiſm on every thing ſuſceptible of magnetic properties; and we cannot heſitate to explain in this way many changes of magnetic direction which have been obſerved. Thus, in Italy, Father de la Torré obſerved, that during a great eruption of Veſuvius the variation was 16° in the morning, at noon it was 14°, and in the evening it was 10°, and that it continued in that ſtate till the lava grew ſo dark as no longer to be viſible in the night; after which it ſlowly increaſed to 13½, where it remained. Daniel Bernoulli found the needle changed its poſition 45′ by an earthquake. Profeſſor Muller at Manheim obſerved that the declination of the needle in that place was greatly affected by the earthquake in Calabria. Such ſtreams of lava as flowed from Hecla in the laſt dreadful eruption muſt have made a transference of magnetic matter that would conſiderably affect the needle. But no obſervations ſeem to have been made on the occaſion; for we know that common ironſtone, which has no effect on the needle, will, by mere cementation with any inflammable ſubſtance, become magnetic. In this way Dr Knight ſometimes made artificial loadſtones.—But theſe are partial things, and not connected with the general change of variation now under conſideration.

We have ſaid ſo much on this ſubject, chiefly with the view of cautioning our readers againſt too ſanguine expectations from any pretenſions to the ſolution of this great problem. We may certainly gather from theſe obſervations, that even although the theory of the variation ſhould be completed, we muſt expect (by what we already know of magnetiſm in general) that the diſturbances of the needle, by local cauſes intervening between it and the great influence by which it is chiefly directed, may be ſo conſiderable as to affect the poſition of the compaſs needle in a very ſenſible manner: for we know that the metallic ſubſtances in the bowels of the earth are in a ſtate of continual change, and this to an extent altogether unknown.

There is another irregularity of the mariner's needle that we have noticed under MAGNETISM, p. 365. namely, the daily variation. This was firſt obſerved by Mr George Graham in 1722 (Philoſophical Tranſactions, N° 383), and reported to the Royal Society of London. It uſually moves (at leaſt in Europe) to the weſtward from 8 morning till 2 P. M. and then gradually returns to its former ſituation. The diurnal variations are ſeldom leſs than 0° 5′, and often much greater. Mr Graham mentions (Philoſophical Tranſactions, N° 428.) ſome obſervations by a Captain Hume, in a voyage to America, where he found the variation greateſt in the afternoon. This being a general phenomenon, has alſo attracted the attention of philoſophers. The moſt detailed accounts of it to be met with are thoſe of Mr Canton (ſee MAGNETISM), in Philoſophical Tranſactions, vol. li. part 1. p. 399, and thoſe of Van Swinden, in his Treatiſe on Electricity and Magnetiſm.

Mr Canton attempts to account for theſe changes of poſition, by obſerving that the force of a magnet is weakened by heat. A ſmall magnet being placed near a compaſs needle, ENE from it, ſo as to make it deflect 45° from the natural poſition, the magnet was covered with a braſs veſſel, into which hot water was poured. The needle gradually receded from the magnet 45′, and returned gradually to its place as the water cooled. This is confirmed by uniform experience.

The parts of the earth to the eaſtward are firſt heated in the morning, and therefore the force of the earth is weakened, and the needle is made to move to the weſtward. But as the ſun warms the weſtern ſide of the earth in the afternoon, the motion of the needle muſt take the contrary direction.

But this way of explaining by a change in the force of the earth ſuppoſes that the changing cauſe is acting in oppoſition to ſome other force. We do not know of any ſuch. The force, whatever it may be, ſeems ſimply to produce its own effect, in deranging the needle from the direction of terreſtrial magnetiſm. If Æpinus's theory of magnetic action be admitted, we may ſuppoſe that the ſun acts on the earth as a magnet acts on a piece of ſoft iron, and in the morning propels the fluid in the north-weſt parts. The needle directs itſelf to this conſtipated fluid, and therefore it points to the eaſtward of the magnetic north in the afternoon. And (to abide by the ſame theory) this induced magnetiſm will be ſomewhat greater when the earth is warmer; and therefore the diurnal variation will be greateſt in ſummer. This change of poſition of the conſtipated fluid muſt be ſuppoſed to bear a very ſmall ratio to the whole fluid, which is naturally ſuppoſed to be conſtipated in one pole of the great magnet in order to give it magnetiſm. Thus we ſhall have the diurnal variation a very ſmall quantity. This is departing, however, from the principle of Mr Canton's explanation; and indeed we cannot ſee how the weakening the general force of the terreſtrial magnet ſhould make any change in the needle in reſpect to its direction; nor does it appear probable that the change of temperature produced by the ſun will penetrate deep enough to produce any ſenſible effect on the magnetiſm. And if this be the cauſe, we think that the derangements of the needle ſhould vary as the thermometer varies, which is not true. The other method of explaining is much better, if Æpinus's theory of magnetic attraction and repulſion be juſt; and we may ſuppoſe that it is only the ſecondary magnetiſm (i. e. that of the magnetiſable minerals) that is ſenſibly affected by the heat; this will account very well for the greater mobility of the fluid in ſummer than in winter.

A great objection to either of theſe explanations is the prodigious diverſity of the diurnal variations in different places. This is ſo very great, that we can ſcarcely aſcribe the diurnal variation to any change in the magnetiſm of the primitive terreſtrial magnet, and muſt rather look for its cauſe in local circumſtances. This concluſion becomes more probable, when we learn that the deviation from the meridian and the deviation from the horizontal line are not affected at the ſame time. Van Swinden aſcribes them ſolely to changes produced on the needles themſelves. If their magnetiſm be greatly deranged by the ſun's poſition, it may throw the magnetic centre away from the centre of the needle's motion, and thus produce a very ſmall change of poſition. But if this be the cauſe, we ſhould expect differences in different needles. Van Swinden ſays, that there are ſuch, and that they are very great; but as he has not ſpecified them, we cannot draw any concluſion.

But, beſides this regular diurnal variation, there is another, which is ſubjected to no rule. The aurora borealis is obſerved (in Europe) to diſturb the needle exceedingly, ſometimes drawing it ſeveral degrees from its poſition. It is always obſerved to increaſe its deviation from the meridian, that is, an aurora borealis makes the needle point more weſterly. This diſturbance ſometimes amounts to ſix or ſeven degrees, and is generally obſerved to be greateſt when the aurora borealis is moſt remarkable.

The obſervation of the connection of the polarity of the needle with the aurora borealis occurred to the late Profeſſor Robiſon in 1759, when a midſhipman on board the Royal William in the river St Lawrence. The point of the heavens to which all the rays of light converged was preciſely that which was oppoſite to the ſouth end of the dipping needle.

This is a very curious phenomenon, and we have not been able to find any connection between this meteor and the poſition of a magnetic needle. It is to be obſerved, that a needle of copper or wood, or any ſubſtance except iron, is not affected. We long thought it an electric phenomenon, and that the needle was affected as any other body balanced in the ſame manner would be; but a copper needle would then be affected.

We ſee the needle frequently diſturbed both from its general annual poſition, and from the change made on it by the diurnal variation. This is probably the effect of auroræ boreales which are inviſible, either on account of thick weather or daylight. Van Swinden ſays, he ſeldom or never failed to obſerve auroræ boreales immediately after any anomalous motion of the needle; and concluded that there had been one at the time, though he could not ſee it. Since no needle but a magnetic one is affected by the aurora borealis, we may conclude that there is ſome natural connection between this meteor and magnetiſm. This ſhould farther incite us to obſerve the circumſtance above mentioned, viz. that the ſouth end of the dipping needle points to that part of the heavens where the rays of the aurora appear to to converge. We wiſh that this were diligently obſerved in places which have very different variation and dip of the mariner's needle.

For the diurnal and this irregular variation, conſult the Diſſertations of Celſius and of Hiorter, in the Memoirs of Stockholm; Wargentin, Philoſophical Tranſactions, vol. xlviii.; Braun (*Comment. Petropol. Novi*, tom. v. vii. ix.); Graham and Canton as above.

VARIETY, a change, ſucceſſion, or difference, in the appearance or nature of things; in oppoſition to *uniformity*.

VARIETY, in *Botany*, is a change in ſome leſs eſſential part or quality; as colour, ſize, pubeſcence or age. —Externally; by the plaiting or interweaving of the branches—by bundling or uniting of ſeveral ſtalks into one broad flat one; by the greater breadth, or narrowneſs, or curling of leaves—by becoming awnleſs, or ſmooth, or hirſute. Internally; by becoming mutilated in the corolla; or having one larger than ordinary —by luxuriancy, multiplication, or fulneſs—by becoming proliferous, or creſted—by bearing bulbs inſtead of ſeeds—or being viviparous.

The uſual cauſes of variation are, climate, ſoil, expoſure, heat, cold, winds, culture.

VARIOLA, the SMALLPOX. See MEDICINE, N° 222—224.

VARIX, in *Medicine*, the dilatation of a vein, ariſing from the too great abundance or thickneſs of the blood.

VARNISH, a clear limpid fluid, capable of hardening without loſing its tranſparency, uſed by painters, gilders, &c. to give a luſtre to their works, to preſerve them and defend them from the air.

A coat of varniſh ought to poſſeſs the following properties: 1. It muſt exclude the action of the air; becauſe wood and metals are varniſhed to defend them from decay and ruſt. 2. It muſt reſiſt water; for otherwiſe the effect of the varniſh could not be permanent. 3. It ought not to alter ſuch colours as are intended to be preſerved by this means. It is neceſſary therefore that a varniſh ſhould be eaſily extended or ſpread over the ſurface, without leaving pores or cavities; that it ſhould not crack or ſcale; and that it ſhould reſiſt water. Now reſins are the only bodies that poſſeſs theſe properties. Reſins conſequently muſt be uſed as the baſes of varniſh. The queſtion which of courſe preſents itſelf muſt then be, how to diſpoſe them for this uſe? and for this purpoſe they muſt be diſſolved, as minutely divided as poſſible, and combined in ſuch a manner that the imperfections of thoſe which might be diſpoſed to ſcale may be corrected by others.

Reſins may be diſſolved by three agents. 1. By fixed oil. 2. By volatile oil. 3. By alcohol. And accordingly we have three kinds of varniſh: the fat or oily varniſh, eſſential varniſh, and ſpirit varniſh. Before a reſin is diſſolved in a fixed oil, it is neceſſary to render the oil drying. For this purpoſe the oil is boiled with metallic oxides; in which operation the mucilage of the oil combines with the metal, while the oil itſelf unites with the oxygen of the oxide. To accelerate the drying of this varniſh, it is neceſſary to add oil of turpentine. The eſſential varniſhes conſiſt of a ſolution of reſin in oil of turpentine. The varniſh being applied, the eſſential oil flies off, and leaves the reſin. This is uſed only for paintings. When reſins are diſſolved in alcohol, the varniſh dries very ſpeedily, and is ſubject to crack; but this fault is corrected by adding a ſmall quantity of turpentine to the mixture, which renders it brighter, and leſs brittle when dry.

We ſhall now give the method of preparing a number of varniſhes for different purpoſes.

A Varniſh for Toilet-boxes, Caſes, Fans, &c.—Diſſolve two ounces of gum maſtich and eight ounces of gum ſandarach in a quart of alcohol; then add four ounces of Venice turpentine.

A Varniſh for Wainſcots, Cane-chairs, Iron-chairs, Grates.—Diſſolve in a quart of alcohol eight ounces of gum ſandarach, two ounces of ſeed lac, four ounces of roſin; then add ſix ounces of Venice turpentine. If the varniſh is wiſhed to produce a red colour, more of the lac and leſs of ſandarach ſhould be uſed, and a little *dragon's blood* ſhould be added. This varniſh is ſo thick that two layers of it are equal to four or five of another.

A Varniſh for Fiddles, and other Muſical Inſtruments.—Put four ounces of gum ſandarach, two ounces of lac, two ounces of gum maſtich, an ounce of gum elemi, into a quart of alcohol, and hang them over a ſlow fire till they are diſſolved; then add two ounces of turpentine.

Varniſh in order to employ Vermilion for painting Equipages.—Diſſolve in a quart of alcohol ſix ounces of ſandarach, three ounces of gum lac, and four ounces of roſin; afterwards add ſix ounces of the cheapeſt kind of turpentine; mix with it a proper quantity of vermilion when it is to be uſed.

Gold-coloured Varniſh.—Pound ſeparately four ounces of ſtick lac, four ounces of gamboge, four ounces of dragon's blood, four ounces of anotta, and one ounce of ſaffron: put each of them ſeparately into a quart of alcohol, and expoſe them for five days in a narrow-mouthed bottle to the ſun, or keep them during that time in a very warm room, ſhaking them every now and then to haſten the ſolution. When they are all melted, mix them together. More or leſs of each of theſe ingredients will give the different tints of gold according as they are combined. In order to make ſilver imitate gold exactly when covered with this varniſh, the quantity of ingredients muſt be ſomewhat greater. The method of gilding ſilver-leaf, &c. with this varniſh is as follows: The ſilver-leaf being fixed on the ſubject, in the ſame manner as gold-leaf, by the interpoſition of proper glutinous matters, the varniſh is ſpread upon the piece with a bruſh or pencil. The firſt coat being dry, the piece is again and again waſhed over with the varniſh till the colour appears ſufficiently deep. What is called *gilt leather*, and many picture frames, have no other than this counterfeit gilding. Waſhing them with a little rectified ſpirit of wine affords a proof of this; the ſpirit diſſolving the varniſh, and leaving the ſilver-leaf of its own whiteneſs. For plain frames, thick tinfoil may be uſed inſtead of ſilver. The tin-leaf, fixed on the piece with glue, is to be burniſhed, then poliſhed with emery and a fine linen cloth, and afterwards with putty applied in the ſame manner: being then lacquered over with the varniſh five or ſix times, it looks very nearly like burniſhed gold. The ſame varniſh, made with a leſs proportion of the colouring materials, is applied alſo on works of braſs; both for heightening the colour of the metal to a reſemblance with that of gold, and for preſerving it from being tarniſhed or corroded by the air.

Oil Varniſhes.—Gum copal and amber are the ſubſtances principally employed in oil varniſhes; they poſſeſs the properties neceſſary for varniſhes, ſolidity and tranſparency.—The copal being whiteſt, is uſed for varniſhing light, the amber for dark colours. It is beſt to diſſolve them before mixing them with the oil, becauſe by this means they are in leſs danger of being ſcorched, and at the ſame time the varniſh is more beautiful. They ſhould be melted in a pot on the fire; they are in a proper ſtate for receiving the oil when they give no reſiſtance to the iron ſpatula, and when they run off from it drop by drop. The oil employed ſhould be a drying oil, and perfectly free from greaſe. It ſhould be poured into the copal or amber by little and little, conſtantly ſtirring the ingredients at the ſame time with the ſpatula. When the oil is well mixed with the copal or amber, take it off the fire; and when it is pretty cool, pour in a greater quantity of the eſſence of turpentine than the oil that was uſed. After the varniſh is made, it ſhould be paſſed through a linen cloth. Oil varniſhes become thick by keeping; but when they are to be uſed, it is only neceſſary to pour in a little eſſence of turpentine, and to put them for a little on the fire. The turpentine is neceſſary in oil varniſhes to make them dry properly; generally twice as much of it is uſed as of oil. Leſs is neceſſary in ſummer than in winter. Too much oil hinders the varniſh from drying; but when too little is uſed, it cracks and does not ſpread properly. We ſhall ſubjoin the moſt uſeful oil varniſhes:

White Copal Varniſh.—On 16 ounces of melted copal pour four, ſix, or eight ounces of linſeed oil, boiled and quite free from greaſe. When they are well mixed, take them off the fire (not forgetting to ſtir them properly); and when pretty cool, pour in 16 ounces of the eſſence of Venice turpentine. Paſs the varniſh through a cloth.—Amber varniſh is made in the ſame way.

Black Varniſh for Coaches and Iron Work.—This varniſh is compoſed of bitumen of Paleſtine, roſin, and amber, melted ſeparately, and afterwards mixed: the oil is then added, and afterwards the turpentine, as directed above. The uſual proportions are, 12 ounces of amber, two ounces of roſin, two ounces of bitumen, ſix of oil, and 12 of the eſſence of turpentine.—Golden-coloured varniſh may be made alſo by ſubſtituting linſeed oil for alcohol.

Eſſential Oil Varniſhes.—The only eſſential oil varniſhes uſed are for pictures. Picture varniſhes ſhould be white, light, and quite tranſparent, which will preſerve the colours without giving them any diſagreeable tint; and it ſhould be poſſible to take them off the picture without injuring it. They are uſually made of gum maſtich and turpentine diſſolved together in ſome eſſential oil. The varniſh is paſſed through a cloth, and allowed to clarify. It is applied cold to the picture.

Varniſh for Glaſs, in order to preſerve it from the Rays of the Sun.—Pulveriſe a quantity of gum adragant, and let it diſſolve for 24 hours in the white of eggs well beat up; then rub it gently on the glaſs with a bruſh.

Varniſhes before they are uſed ſhould be carefully kept from duſt, which would ſpoil them; and they ſhould be kept in a veſſel quite clean and dry. When uſed, they ſhould be lifted lightly with a bruſh, and ſpread upon a ground altogether free from dirt and moiſture. The ſubſtance, after being varniſhed, ſhould be expoſed to the heat of the ſun, or placed in a warm room covered with a glaſs caſe, to keep out all filth. Oil varniſhes require more heat than alcohol varniſhes. The varniſh ſhould be put on very quickly, making great ſtrokes with the pencil or bruſh, taking care that theſe ſtrokes never croſs one another; it ſhould be ſpread equally, and never thicker than a leaf of paper; a ſecond coat ſhould not be put on till the firſt is quite dry. If the varniſh, after being put on, becomes dull and uneven, it muſt be taken off entirely, and new varniſh put on.

When wainſcot is to be varniſhed, it is firſt painted of a wooden colour. This colour is made by infuſing in water either red or yellow ochre (according to the colour wiſhed for), terra ombria (a kind of ochre) and white lead; into this as much as neceſſary is put of *parchment paſte*. Two thin coats of this are to be put on, and, after they are quite dry, the varniſh.

Varniſhes are poliſhed with pumice-ſtone and tripoli earth. The pumice-ſtone muſt be reduced to an impalpable power, and put upon a piece of ſerge moiſtened with water; with this the varniſhed ſubſtance is to be rubbed lightly and equally. The tripoli muſt alſo be reduced to a very fine powder, and put upon a clean woollen cloth moiſtened with olive oil, with which the poliſhing is to be performed. The varniſh is then to be wiped with ſoft linen, and, when quite dry, cleaned with ſtarch or Spaniſh white, and rubbed with the palm of the hand or with a linen cloth.

To recover colours or varniſh, and to take off the dirt and filth which may adhere to them, a ley is uſed made of potaſh and the aſhes of lees of wine. Take 48 ounces of potaſh, and 16 of the above-mentioned aſhes, and put them into ſix quarts of water, and the ley is made: inſtead of the aſhes an equal quantity of potaſh would probably do as well. To clean dirty colours, dilute ſome of this ley with four times its quantity of water, and rub the picture with it; then waſh it with river water; and when dry, give it a coat or two of varniſh. In order to take off a varniſh, waſh it with the above-mentioned ley, then with water, and then lift it off the ſubſtance on which it was with any iron inſtrument.—We ſhall finiſh this article with a deſcription of the famous Chineſe varniſh.

The Chineſe varniſh is not a compoſition. but a reſin which exudes from a tree called in China *tſi-chu*, "varniſh tree." This tree grows in ſeveral provinces of the ſouthern parts of China. The Chineſe take the following method of propagating this tree: In ſpring they chooſe a vigorous ſhoot about a foot in length, which proceeds immediately from the trunk; and coat over the lower part, by which it adheres to the tree, with a kind of yellow earth, at leaſt three inches in thickneſs. This coat is carefully covered with a mat, to defend it from rain and the injuries of the air. Towards the autumnal equinox they detach a little of the earth, to obſerve in what condition the ſmall roots are, which begin to ſpring forth from the ſhoot. If they find that the filaments which compoſe them are of a reddiſh colour, they judge it is time to make an amputation; but they defer it if the roots are white, becauſe this colour ſhows that

that they are yet too tender: they then cloſe up the coat again, and wait till the ſpring following. When the ſhoot is ſeparated from the trunk of the tree, it is put into the earth; but in whatever ſeaſon it is planted, whether in ſpring or autumn, great care muſt be taken to put plenty of cinders into the hole prepared for it; without this precaution the ants would deſtroy the yet tender ſhoots, or at leaſt deprive them of all their moiſture, and cauſe them to decay.

The Chineſe do not procure varniſh from the tſi-chu until its trunk is nearly five inches in diameter, which ſize it ſeldom attains to before ſeven or eight years. Varniſh extracted from a tree ſmaller or of leſs age would not have the ſame body and ſplendor. This liquor diſtils only in the night time, and during the ſummer ſeaſon. To cauſe the gum to flow, they make ſeveral rows of inciſions round the trunk, the number of which is proportioned to the vigour of the tree. The firſt row is ſeven inches from the earth, and the reſt are at the ſame diſtance one from the other, and continue to the top of the trunk, and even ſometimes on the boughs which are of ſufficient ſtrength and ſize. The Chineſe uſe a crooked iron for making theſe inciſions, which muſt run a little obliquely, and be equal in depth to the thickneſs of the bark; they make them with one hand, and with the other hold a ſhell, the edges of which they inſert into the opening, where it remains without any ſupport. Theſe inciſions are made towards evening, and next morning they collect the varniſh which has fallen into the ſhells; the following evening they are again inſerted, and this operation is continued until the end of ſummer. A thouſand trees yield almoſt in one night 20 pounds of varniſh.

While the varniſh diſtils, it exhales a maligant vapour, the bad effects of which can only be prevented by preſervatives and great precaution. The merchant who employs the workmen is obliged to keep by him a large vaſe filled with rape-oil, in which a certain quantity of thoſe fleſhy filaments have been boiled that are found in hog's lard, and which do not melt. When the workmen are going to fix the ſhells to the trees, they carry ſome of this oil along with them, and rub their face and hands with it, which they do with greater care when they collect in the morning the varniſh that has diſtilled during night. After eating, they waſh their whole bodies with warm water, in which the bark of the cheſnut tree, fir wood, cryſtallized ſaltpetre, and ſome other drugs, have been boiled. When they are at work near the trees, they put upon their heads a ſmall cloth bag in which there are two holes, and cover the fore part of their bodies with a kind of apron made of doe ſkin, which is ſuſpended from their necks with ſtrings, and tied round them with a girdle. They alſo wear boots, and have coverings on their arms, made of the ſame kind of ſkin. The labourer who ſhould attempt to collect varniſh without uſing this precaution, would ſoon be puniſhed for his raſhneſs, and the moſt dreadful effects would enſue. The diſorder ſhows itſelf by tetters, which become of a bright red colour, and ſpread in a very ſhort time; the body afterwards ſwells, and the ſkin burſts and appears covered with an univerſal leproſy. The unhappy wretch could not long endure the excruciating pain which he feels, did he not find a ſpeedy remedy in thoſe preſervatives which are uſed againſt the malignant and noxious exhalations of the varniſh.

The ſeaſon of collecting varniſh being ended, the merchant puts it into ſmall caſks cloſely ſtopped. A pound of it newly made coſts him about one ſhilling and eight pence Sterling; but he gains *cent. per cent.* upon it, and ſometimes more, according to the diſtance of the place to which he tranſports it.

Beſides the luſtre and beauty which that varniſh gives to many of the Chineſe manufactures, it has alſo the property of preſerving the wood upon which it is laid, eſpecially if no other matter be mixed with it. It prevents it from being hurt either by dampneſs or worms.

Every workman has a particular art and method of uſing the varniſh. This work requires not only much ſkill and dexterity, but alſo great attention, to obſerve the proper degree of fluidity which the gum ought to have, as it muſt be neither too thick nor too liquid when it is laid on. Patience above all is neceſſary in thoſe who wiſh to ſucceed. To be properly varniſhed, a work muſt be done at leiſure; and the whole ſummer is ſcarcely ſufficient to bring it to perfection. It is therefore rare to ſee any of thoſe cabinets which are imported to us from Canton ſo beautiful and durable as thoſe manufactured in Japan, Tong-king, and Nang-king, the capital of the province of Kiang-nan: not that the artiſts do not employ the ſame varniſh; but as they work for Europeans, who are more eaſily pleaſed, they do not take the trouble of giving the pieces which come from their hands all the poliſh they are capable of receiving.

There are two methods of laying on the varniſh; the ſimpleſt is, when it is immediately laid on the wood. The work is firſt poliſhed, and then daubed over with a kind of oil which the Chineſe call *tong-yeou*. When this oil is dry, it receives two or three coats of varniſh; which remain ſo tranſparent, that all the ſhades and veins of the wood may be ſeen through them. If the artiſt is deſirous of entirely concealing the ſubſtance on which they are laid, nothing is neceſſary but to add a few more coats; theſe give the work a ſhining ſurface, the ſmoothneſs of which equals that of the moſt beautiful ice. When the work is dry, various figures are painted upon it in gold and ſilver, ſuch as flowers, birds, trees, temples, dragons, &c. A new coat of varniſh is then ſometimes laid over theſe figures, which preſerves them, and adds much to their ſplendor. The ſecond method requires more preparation. The Chineſe workmen fix to the wood by means of glue a kind of paſteboard, compoſed of paper, hemp, lime, and other ingredients, well beaten, that the varniſh may incorporate with them. Of this they make a ground perfectly ſmooth and ſolid, over which the varniſh is laid in thin coats, that are left to dry one after the other.

It often happens, that the luſtre of varniſhed tables and other pieces of furniture is inſenſibly deſtroyed by tea and warm liquors. "The ſecret of reſtoring to varniſh its ſhining black colour (ſays a Chineſe author) is to expoſe it for one night to a white hoar-froſt, or to cover it ſome time with ſnow." For a method of imitating *Chineſe varniſh*, ſee TURNING.

VARNISH alſo ſignifies a ſort of ſhining coat, wherewith potters-ware, delft-ware, china-ware, &c. are covered,

vered, which gives them a ſmoothneſs and luſtre. Melted lead is generally uſed for the firſt, and ſmalt for the ſecond. See GLAZING.

VARNISH, among medaliſts, ſignifies the colours antique medals have acquired in the earth.

The beauty which nature alone is able to give to medals, and art has never yet attained to counterfeit, enhances the value of them: that is, the colour which certain ſoils in which they have a long time lain tinges the metals withal: ſome of which are blue, almoſt as beautiful as the turquoiſe; others with an inimitable vermilion colour; others with a certain ſhining poliſhed brown, vaſtly finer than Braſil figures.

The moſt uſual varniſh is a beautiful green, which hangs to the fineſt ſtrokes without effacing them, more accurately than the fineſt enamel does on metals.

No metal but braſs is ſuſceptible of this; for the green ruſt that gathers on ſilver always ſpoils it, and it muſt be got off with vinegar or lemon juice.

Falſifiers of medals have a falſe or modern varniſh, which they uſe on their counterfeits, to give them the appearance or air of being antique. But this may be diſcovered by its ſoftneſs; it being ſofter than the natural varniſh, which is as hard as the metal itſelf.

Some depoſite their ſpurious metals in the earth for a conſiderable time, by which means they contract a ſort of varniſh, which may impoſe upon the leſs knowing; others uſe ſal ammoniac, and others burnt paper.

VARRO, MARCUS TERENTIUS, the moſt learned of all the Romans, was born 28 years B. C. He was a ſenator of the firſt diſtinction, both for birth and merit; and bore many great offices. He was an intimate friend of Cicero; and this friendſhip was confirmed and immortalized by a mutual dedication of their learned works to each other. Thus Cicero dedicated his Academic Queſtions to Varro; and Varro dedicated his treatiſe on the Latin tongue to Cicero. In the civil wars he was zealouſly attached to Pompey; but after his defeat ſoon ſubmitted to Cæſar, who was reconciled to him. Afterwards he applied his whole time to letters, and had the charge of the Greek and Latin libraries at Rome. He was above 70 when Antony proſcribed him; however, he found means to eſcape and ſave his life, though he could not ſave ſome of his works and his library from being plundered by the ſoldiers. After this ſtorm was over, he purſued his ſtudies as uſual; and Pliny relates, that he continued to ſtudy and to write when he was 88 years of age. He was 80 when he wrote his three books *De re Ruſtica*, which are ſtill extant. Five of his books *De lingua Latina*, which he addreſſed to Cicero, are all extant. There remain, too, divers fragments of his works, particularly of his Menippean Satires, which are medleys of proſe and verſe; and Scaliger has collected ſome of his epigrams from among the *Catalecta Virgilii*. His books *De lingua Latina*, and *De re Ruſtica*, were printed with the notes of Joſeph Scaliger, Turnebus, and Victorius, by Henry Stephens at Paris, 1573, in 8vo, and have been publiſhed ſeparately ſince among the *Auctores de lingua Latina*, and the *Auctores de re Ruſtica*.

There was another Varro of antiquity, called *Atacinus*, who was born about 10 years after the firſt, at a ſmall town near Narbonne. Though infinitely below the Roman in learning, he was at leaſt as good, if not a better, poet; which perhaps has made Lillius Gyraldus and other critics confound them. He compoſed many works in verſe; ſome fragments of which were collected, and publiſhed with thoſe of other ancient poets, at Lyons in 1603. His chief works were, A poem on the war with the Sequani, a people of Gaul; and the Aſtronomics, that went under the name of Planciades the grammarian. But the *Argonautics*, in four books, was what gained him the greateſt reputation: and though indeed nothing but a tranſlation of Apollonius Rhodius, yet was ſo well done as to be commended by Quintilian.

VARRONIA, a genus of plants belonging to the claſs pentandria, and arranged in the natural ſyſtem under the 41ſt order, *Aſperifoliæ*. See BOTANY *Index*.

VASCULAR, ſomething conſiſting of divers veſſels, as arteries, veins, &c.

VASE, a term frequently uſed for ancient veſſels dug from under ground, or otherwiſe found, and preſerved in the cabinets of the curious. In architecture, the appellation *vaſe* is alſo given to thoſe ornaments placed on corniches, ſochles, or pedeſtals, repreſenting the veſſels of the ancients, particularly thoſe uſed in ſacrifice, as incenſe-pots, flower-pots, &c. See *PORTLAND-Vaſe*.

VASSAL, in our ancient cuſtoms, ſignified a tenant or feudatory; or perſon who vowed fidelity and homage to a lord, on account of ſome land, &c. held of him in fee; alſo a ſlave or ſervant, and eſpecially a domeſtic of a prince.—*Vaſſallus* is ſaid to be *quaſi inferior ſocius*; as the vaſſal is inferior to his maſter, and muſt ſerve him; and yet he is in a manner his companion, becauſe each of them is obliged to the other. See *FEODAL Syſtem*.

VATICAN, a magnificent palace of the pope in Rome, which is ſaid to conſiſt of ſeveral thouſand rooms: but the parts of it moſt admired are the grand ſtaircaſe, the pope's apartment, and eſpecially the library, which is one of the richeſt in the world, both in printed books and manuſcripts.

VAUBAN, SEBASTIAN LE PRESTRE, SEIGNEUR DE, marſhal of France, and the greateſt engineer that country ever produced, was born in 1633. He diſplayed his knowledge of fortification in the courſe of many ſieges, and his ſervices were rewarded with the firſt military honours. He was made governor of Liſle in 1668, commiſſary general of the fortifications of France in 1678, governor of the maritime parts of Flanders in 1689, and a marſhal of France in 1703. He died in 1707, after having brought the arts of attacking and defending fortified places to a degree of perfection unknown before. His writings on theſe ſubjects are in great eſteem.

VAUDOIS, VALDENSES, or *Waldenſes*, in eccleſiaſtical hiſtory, a name given to a ſect of reformers, who made their firſt appearance about the year 1160.

The origin of this famous ſect, according to Moſheim, was as follows: Peter, an opulent merchant of Lyons, ſurnamed *Valdenſis*, or *Validiſius* from Vaux or Waldum, a town in the marquiſate of Lyons, being extremely zealous for the advancement of true piety and Chriſtian knowledge, employed a certain prieſt called *Stephanus de Eviſa*, about the year 1160, in tranſlating from Latin into French the four Goſpels, with other books of Holy Scripture, and the moſt remarkable ſentences of the ancient doctors, which were ſo highly eſteemed in this century. But no ſooner had he peruſed theſe ſacred books with a proper degree of attention, than he perceived that the religion which was now taught in the Roman church, differed totally from that which was originally inculcated by Chriſt and his apoſtles. Struck with this glaring contradiction between the doctrines of the pontiffs and the truths of the Goſpel, and animated with zeal, he abandoned his mercantile vocation, diſtributed his riches among the poor (whence the Waldenſes were called *poor men of Lyons*), and forming an aſſociation with other pious men, who had adopted his ſentiments and turn of devotion, he began in the year 1180 to aſſume the quality of a public teacher, and to inſtruct the multitude in the doctrines and precepts of Chriſtianity.

Soon after Peter had aſſumed the exerciſe of his miniſtry, the archbiſhop of Lyons, and the other rulers of the church in that province, vigorouſly oppoſed him. However, their oppoſition was unſucceſsful; for the purity and ſimplicity of that religion which theſe good men taught, the ſpotleſs innocence that ſhone forth in their lives and actions, and the noble contempt of riches and honours which was conſpicuous in the whole of their conduct and converſation, appeared ſo engaging to all ſuch as had any ſenſe of true piety, that the number of their followers daily increaſed.—They accordingly formed religious aſſemblies, firſt in France, and afterwards in Lombardy, from whence they propagated their ſect throughout the other provinces of Europe with incredible rapidity, and with ſuch invincible fortitude, that neither fire, nor ſword, nor the moſt cruel inventions of mercileſs perſecution, could damp their zeal, or entirely ruin their cauſe.

VAULT, in *Architecture*, an arched roof, ſo contrived that the ſtones which form it ſuſtain each other.

Vaults are on many occaſions to be preferred to ſoffits, or flat ceilings, as they give a greater height and elevation, and are beſides more firm and durable.

VAYER. See MOTHE.

VAYVODE, or VAIVODE. See WAYWODE.

UBES, ST, a ſea-port town of Portugal, in the province of Eſtremadura, ſeated on a bay of the Atlantic ocean, 21 miles ſouth of Liſbon. It ſtands on an eminence, with a very ſtrong caſtle built on a rock. The ſoil around is fertile in corn, wine, and fruits; and it is furniſhed with good fiſh from the ſea, and a ſmall lake in the neighbourhood. Here great quantities of fine ſalt are made, which is carried to the American plantations. E. Long. 8. 54. N. Lat. 38. 22.

UBIQUITARIANS, formed from *ubique*, "everywhere," in eccleſiaſtical hiſtory, a ſect of Lutherans which roſe and ſpread itſelf in Germany; and whoſe diſtinguiſhing doctrine was, that the body of Jeſus Chriſt is everywhere, or in every place.

Brentius, one of the earliſt reformers, is ſaid to have firſt broached this error, in 1560. Luther himſelf, in his controverſy with Zuinglius, had thrown out ſome unguarded expreſſions, that ſeemed to imply a belief of the omnipreſence of the body of Chriſt; but he became ſenſible afterwards, that this opinion was attended with great difficulties, and particularly that it ought not to be made uſe of as a proof of Chriſt's corporal preſence in the euchariſt. However, after the death of Luther, this abſurd hypotheſis was renewed, and dreſſed up in a ſpecious and plauſible form by Brentius, Chemnitius, and Andræas, who maintained the communication of the properties of Chriſt's divinity to his human nature. It is indeed obvious, that every Lutheran who believes the doctrine of conſubſtantiation (ſee SUPPER *of the Lord*), whatever he may pretend, muſt be an Ubiquitarian.

UBIQUITY, OMNIPRESENCE; an attribute of the Deity, whereby he is always intimately preſent to all things; gives the *eſſe* to all things; knows, preſerves, and does all in all things.

UDDER, in comparative anatomy, that part in brutes wherein the milk is prepared, anſwering to the mammæ or breaſts in women. See ANATOMY, COMPARATIVE.

VEDAS, the ſacred books of the Hindoos, believed to be revealed by God, and called *immortal*. They are conſidered as the fountain of all knowledge human and divine, and are four in number; of which we have the following account in the firſt volume of the Aſiatic Reſearches: The *Rigveda* conſiſts of five ſections; the *Yajurveda* of eighty ſix; the *Samaveda* of a thouſand; and the *At'harvaveda* of nine; with eleven hundred *ſac'ha's*, or branches, in various diviſions and ſubdiviſions. The *Vedas* in truth are infinite; but have been long reduced to this number and order: the principal part of them is that which explains the duties of man in a methodical arrangement; and in the fourth is a ſyſtem of divine ordinances.

From theſe are reduced the four *Upavedas*, the firſt of which was delivered to mankind by BRAHMA, INDRA, DHANWANTARI, and five other deities; and compriſes the theory of diſorders and medicines, with the practical methods of curing diſeaſes.

The ſecond conſiſts of muſic, invented for the purpoſe of raiſing the mind by devotion to the felicity of the Divine nature; the third treats of the fabrication and uſe of arms; and the fourth of *ſixty-four* mechanical arts. Of however little value we may eſteem the mechanical arts of the Hindoos, and however deſpicable their theological ſyſtem may really be, the *Upaveda*, which treats of diſeaſes and the method of curing them, ſurely deſerves to be ſtudied by every European phyſician practiſing in India. There are indeed a great number of medical books in the Shanſcrit language worthy of attention; for though the theories of their authors may be groundleſs and whimſical, they contain the names and deſcriptions of many Indian plants and minerals, with their uſes, diſcovered by *experience*, in the cure of diſeaſes.

VEDETTE, in *War*, a centinel on horſeback, with his horſe's head towards the place whence any danger is to be feared, and his carabine advanced, with the butt-end againſt his right thigh. When the enemy has encamped, there are vedettes poſted at all the avenues, and on all the riſing grounds, to watch for its ſecurity.

To **VEER** *and* HAUL, to pull a rope tight, by drawing it in and ſlackening it alternately, till the body to which it is applied acquires an additional motion, like the increaſed vibrations of a pendulum, ſo that the rope is ſtraitened to a greater tenſion with more facility and diſpatch. This method is particularly uſed in hauling the bowlines.

The wind is ſaid to veer and haul when it alters its direction, and becomes more or leſs fair. Thus it is ſaid to veer aft and to haul forward.

VEER, *Ter-Veer*, anciently *Camp-Veer*, a town of Zealand in the United Provinces, ſtanding at the mouth of the Eaſt Schelde, about four miles from Middleburgh, and eight from Fluſhing. Veer, in Dutch, ſignifies a paſſage or ferry over an arm of the ſea or a river; and as there was once a ferry here over the Schelde to the village of Compen, on the iſland of North Beveland, the town thereby got the name of *Veer*, *Camp-Veer*, and *Ter-Veer*. It is well fortified, and formerly enjoyed a good trade, eſpecially to Scotland; the natives enjoying particular privileges here. The harbour is very good, and the arſenal the beſt furniſhed in the world. Hence the Veres, anciently earls of Oxford, are ſaid to have derived both their origin and name.

VEERING, or WEARING, the operation by which a ſhip, in changing her courſe from one board to the other, turns her ſtern to windward. Hence it is uſed in oppoſition to TACKING, wherein the head is turned to the wind and the ſtern to leeward. See SEAMANSHIP.

VEGA, LOPEZ DE, a celebrated Spaniſh poet. He was the ſon of Felix de Vega and Franciſca Fernandez, who were both deſcended from honourable families, and lived in the neighbourhood of Madrid. Our poet was born in that city on the 25th of November 1562. He was, according to his own expreſſion, a poet from his cradle; and beginning to make verſes before he had learned to write, he uſed to bribe his elder ſchool-fellows with part of his breakfaſt, to commit to paper the lines he had compoſed. Having loſt his father while he was yet ſtill a child, he engaged in a frolic very natural to a lively boy, and wandered with another lad to various parts of Spain, till, having ſpent their money, and being conducted before a magiſtrate at Segovia for offering to ſell a few trinkets, they were ſent home again to Madrid. Soon after this adventure, our young poet was taken under the protection of Geronimo Manrique, biſhop of Avila, and began to diſtinguiſh himſelf by his dramatic compoſitions, which were received with great applauſe by the public, though their author had not yet completed his education: for, after this period, he became a member of the univerſity of Alcalà, where he devoted himſelf for four years to the ſtudy of philoſophy. He was then engaged as ſecretary to the duke of Alva, and wrote his Arcadia in compliment to that patron: who is frequently mentioned in his occaſional poems. He quitted that employment on his marriage with Iſabel de Urbina, a lady (ſays his friend and biographer Perez de Montalvan) beautiful without artifice, and virtuous without affectation. His domeſtic happineſs was ſoon interrupted by a painful incident:—Having written ſome lively verſes in ridicule of a perſon who had taken ſome injurious freedom with his character, he received a challenge in conſequence of his wit; and happening, in the duel which enſued, to give his adverſary a dangerous wound, he was obliged to fly from his family, and ſhelter himſelf in Valencia. He reſided there a conſiderable time; but connubial affection recalled him to Madrid. His wife died in the year of his return. His affliction at this event led him to relinquiſh his favourite ſtudies, and embark on board the Armada which was then preparing for the invaſion of England. He had a brother who ſerved in that fleet as a lieutenant) and being ſhot in an engagement with ſome Dutch veſſels, his virtues were celebrated by our afflicted poet, whoſe heart was peculiarly alive to every generous affection. After the ill ſucceſs of the Armada, the diſconſolate Lopez de Vega returned to Madrid, and became ſecretary to the marquis of Malpica, to whom he has addreſſed a grateful ſonnet. From the ſervice of this patron he paſſed into the houſehold of the count of Lemos, whom he celebrates as an inimitable poet. He was once more induced to quit his attendance on the great, for the more inviting comforts of a married life. His ſecond choice was Juana de Guardio, of noble birth and ſingular beauty. By this lady he had two children, a ſon who died in his infancy, and a daughter named *Feliciana*, who ſurvived her father. The death of his little boy is ſaid to have haſtened that of his wife, whom he had the misfortune to loſe in about ſeven years after his marriage. Having now experienced the precariouſneſs of all human enjoyments, he devoted himſelf to a religious life, and fulfilled all the duties of it with the moſt exemplary piety: ſtill continuing to produce an aſtoniſhing variety of poetical compoſitions. His talents and virtues procured him many unſolicited honours. Pope Urban VIII. ſent him the croſs of Malta, with the title of Doctor in Divinity, and appointed him to a place of profit in the Apoſtolic Chamber; favours for which he expreſſed his gratitude by dedicating his *Corona Tragica* (a long poem on the fate of Mary queen of Scots) to that liberal pontiff. In his 73d year he felt the approaches of death, and prepared himſelf for it with the utmoſt compoſure and devotion. His laſt hours were attended by many of his intimate friends, and particularly his chief patron the duke of Seſſa, whom he had made his executor; leaving him the care of his daughter Feliciana, and of his various manuſcripts. The manner in which he took leave of thoſe he loved was moſt tender and affecting. He ſaid to his diſciple and biographer Montalvan, That true fame conſiſted in being good: and that he would willingly exchange all the applauſes he had received to add a ſingle deed of virtue to the actions of his life. Having given his dying benediction to his daughter, and performed the laſt ceremonies of his religion, he expired on the 25th of Auguſt 1635.

VEGETABLE PHYSIOLOGY.—Under the article BOTANY, and alſo under PLANT, we have already delivered ſome of the commonly received doctrines on this ſubject. But as ſome late inveſtigations ſeem to lead to new views with regard to the ſtructure and nature of vegetables, we have thought it neceſſary to reſume the ſubject, and to give as full a detail of the experiments and obſervations to which we allude as our limits will permit: we ſhall firſt treat of the ſtructure, and ſecondly of the phyſiology of plants.

I. STRUCTURE OF PLANTS.—In conſidering the ſtructure or anatomy of plants, we ſhall treat, 1ſt, of the root; 2d, of the ſtem and branches; 3d, of the leaves; and 4th, of the flowers; in the order in which they are now enumerated.

1. *The Root.*—The root is that organ belonging to vegetables by which they are ſupplied with nouriſhment, and by which they are fixed to a commodious ſituation.

It was formerly ſuppoſed to be compoſed of outer and inner bark, of wood and of pith; but Mrs Ibbetſon, who has lately communicated[*] to the public the reſults of an elaborate

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[*] *Nich. Jour.* xxiii. 161. and 334.

elaborate ſeries of experiments on this ſubject, thinks that it is wholly compoſed of the rind much thickened, with perhaps a very little of the outer bark, but no inner bark; of a quantity of wood, hardly any pith, and no ſpiral veſſels. Mrs Ibbetſon ſearched in vain for the larger veſſels of the inner bark, till it occurred to her that the want of this bark accounted for there being no leaves on the root. Mrs Ibbetſon had often been aſſured that roots were found bearing leaves, but on diſſection of theſe ſuppoſed roots, ſhe found that they were branches which croſſed the root.

The root conſiſts of the caudex, ſtock or main body, and of the radiculæ or fibres which ariſe from the caudex, and are the organs by which the moiſture is immediately imbibed.

In botanical terminology, we generally conſider all that part of a plant which is under ground as the root; but Linné comprehends under his definition, what we term the body or trunk of the plant; and he went ſo far as to call the ſtems of trees "*roots above ground*"; but as Dr Smith juſtly remarks, this ſeems paradoxical and ſcarcely correct. Dr Smith adds, that perhaps it would be more accurate to call the caudex a *ſubterraneous ſtem;* although he is rather inclined to think that it has functions diſtinct from the ſtem, analogous to digeſtion; for there is evidently a great difference in many caſes, between the fluids of the root, at leaſt the ſecreted ones, and thoſe of the reſt of the plant.

In botanical phyſiology, by the term *root*, is often underſtood the parts only which ſerve to keep the plants firm in the ground: thus the bulbous and fleſhy roots as they are called, are ſtrictly ſpeaking, not roots; the radiculæ or fibres being the real roots. The duration of roots is various; they are either annual, biennial, or perennial.

2. *The* S*TEMS and* B*RANCHES*.—Linné long ago divided the ſtems of trees into four parts; the rind, the bark, the wood, and the pith: and nearly a ſimilar diviſion has been adopted by moſt vegetable phyſiologiſts till the preſent time.

Mrs Ibbetſon (aided by a powerful ſolar microſcope), however, thinks that nature points out a more regular diviſion, a diviſion marked not only by the form, but by the difference of the *juices*, with which the parts are ſwelled.

Mrs Ibbetſon divides the ſtem of trees into ſix parts: 1. The rind; 2. The bark and inner bark; 3. The wood; 4. The ſpiral nerves; 5. The nerves or circle of life (corona of Hill); and 6. The pith.

1. *Of the rind*.—Mrs Ibbetſon conceives the rind to be merely an outward covering to the tree, which prevents its juices from being evaporated by the influence of the ſun's heat. The rind is continued under ground; but it may be as uſeful there to prevent the entrance of the duſt and earth, the preſſure of ſtones, or the injury of inſects.

The rind is compoſed of two rows of cylinders, with a ſingle line to divide them. The cylinders are filled with a pellucid liquor. There are ſeldom more than four or five layers of veſſels in the rind; but it is in general ſo covered with paraſitic plants, as powdery lichens, &c. that its thickneſs is often more than doubled.

The rind does not appear to be neceſſary to plants in general, as there are many in which the bark ſerves as a covering in its ſtead; but it ſeems to form an eſſential part of trees.

2. *Of the bark and inner bark*.—Theſe parts, though certainly different as to *form*, contain the ſame kind of juice; and being ſo nearly allied, may be treated of as one. From the bark and inner bark the leaves take their origin, as will be ſhown when we come to treat of the formation of the leaf-bud. Mrs Ibbetſon conceives that the juice of the bark is the blood of the tree.

In the bark alone are produced the gums, the reſins, the oil, the milk, &c.; in ſhort all that belongs to the tree; gives taſte to it; all that makes one plant differ from another, and all its virtues, if the expreſſion may be uſed. The bark is generally green; the inner bark white, yellow, or green. The former conſiſts of veſſels croſſing each other; the latter of bundles of veſſels of two ſizes. The large veſſels conſiſt of broad cylinders, having a bottom with a hole in it, through which the liquid paſſes, though not with perfect eaſe.

Mrs Ibbetſon ſays that on expoſing ſeveral pieces of the inner bark to the ſolar microſcope, the moment ſhe turned the light on the ſpecimen, the juice, which had before proceeded up the pipes rather ſlowly, was ſuddenly propelled forward with a force truly aſtoniſhing.

When the heat and light were increaſed by cauſing the focus of the rays to fall on the veſſels, the ſide diviſions of the veſſels were broken through, thus inundating the ſpecimen; but when a proper degree of light and heat was kept up, it was curious to obſerve the liquid paſſing from pipe to pipe, in one regular and eaſy flow, making only a ſhort ſtop as it iſſued through the ſtraitened apertures at the bottom of the veſſels. Mrs Ibbetſon has often ſtood for more than an hour watching the current, (which paſſes, however, much ſlower than the ſap does), nor could ſhe perceive while the heat and light were on it, that it required any additional expedient to haſten its momentum; but during the cold and darkneſs of night, ſhe ſuppoſes that the preſſure of the baſtard grain mentioned by Mr Knight, may very likely aſſiſt its flow, as it is at night that the baſtard grain is preſſed againſt the cylinders.

The baſtard grain is found however only in the wood; but the contraction at the bottom of the large veſſels of the inner bark, may probably ſerve the ſame purpoſe, the impetus of the current being increaſed by the leſſening of the apertures of the veſſels.

The veſſels of the inner bark are very thick in proportion to their ſize, and there is placed in them a peculiar circular body, which reſembles a cullender full of holes ſo ſmall that no liquid could paſs them. In viewing the thick juice which runs through theſe pipes, Mrs Ibbetſon obſerved many bubbles of air, the ſize of which was increaſed or diminiſhed according to the temperature; and as their ſize varied, ſo was the flow of the liquid accelerated or retarded. To ſee theſe veſſels well, the ſpecimens may be placed in a baſket which is to be faſtened in a running ſtream for ſome time, or boiled thoroughly, and then thrown into green wax perfectly melted.

Mirbel ſays that "ſome plants have the ſame juices in every part of them:" but Mrs Ibbetſon does not coincide with his idea, for ſhe did not find it to be ſo; though the potent ſmell of the liquid belonging to the bark often extends to other parts of the plant, yet it generally vaniſhes if kept ſeparate for a day, or becomes ſo faint

faint in compariſon with the real liquid of the bark as to prove that it does not form an ingredient of theſe parts. Mirbel ſays that the cylinders of the inner bark are merely vacancies of the ordinary veſſels; but Mrs Ibbetſon ſtates that they are exactly the ſame as theſe veſſels, and occupy the ſame place.

They have a peculiar ſhape, being unlike any other veſſels of the tree, and they perform a particular office.

The veſſels of the bark are ſmaller, and more ſimple than thoſe of the inner bark, and are divided by a line or two, running longitudinally between them.

3. *Of the Wood.*—This is a very obvious part. Place the ſtem of any plant in a coloured liquid, and every veſſel which conveys the ſap from the earth to the top of the tree will be tinged.

The ſap is a thin watery liquor, probably medicated from the earth, in order to become ſuitable for the life of vegetables.

Mrs Ibbetſon ſuppoſes that the ſap may vary with the ſoil, though on trial ſhe has never found that change which might have been ſuſpected.

If we make a tranſverſe ſection of the ſtem of a tree, two different kinds of layers preſent themſelves in the wood; ſome running in a circular manner, which timber merchants call the *ſilver grain;* and others from the circumference to the centre, which they denominate the *baſtard grain.* Linné long ago believed that one of the circular layers was added to the tree each year. This opinion has often been controverted, and among others by Duhamel and Mirbel; but Mrs Ibbetſon has had an opportunity of verifying the accuracy of Linné's opinion. She alſo obſerved that the layer was large or ſmall according to the expoſure of the tree, and the favourableneſs of the ſeaſon: thus in expoſed ſituations, the circles taken as a whole, were much narrower than in trees not expoſed. In ſome trees ſhe noticed only half of a circular layer.

Mrs Ibbetſon thinks the baſtard ſtripe conſiſts of two lines or ſtrings, with a little ſcale between them; and they appear from their extreme ſuſceptibility to be formed of the ſame leather-like ſubſtance as the ſpiral veſſels, which we are immediately to notice.

Mr Knight merely calls them *ſcales;* but as he mentions their preſſing cloſe (which they certainly do) to the cylinders at night, and during cold weather, it is obvious (whichever of the opinions we adopt) that the baſtard grains are capable of ſupplying the place of the ſun's rays, by their preſſure.

The wood-veſſels are far more ſimple in ſtructure than thoſe of the bark; they are very narrow cylinders, and the two rows next to the corona are covered by the ſpiral veſſels.

It is indeed difficult to determine the exact extent of the ſpiral veſſels even with the aſſiſtance of the ſolar microſcope, for it is by *unwinding* them alone that they can be known; and their extreme fineneſs confuſes, in conſequence of which they have been taken for ſap veſſels. Neither Mr Knight nor Mirbel was led into this miſtake, and Mrs Ibbetſon thinks that there can be no doubt that theſe veſſels (formerly ſo called) are ſolid ſtrings which hold no liquid.

The veſſels of the wood may be beſt ſeen in ſlices of the ſtems of young trees; and if not very viſible when recently cut, they will ſoon become ſo if the ſlices are kept in a dry place.

If the wood-veſſels are cut longitudinally and obſerved with a high magnifier, as ſoon as the light is permitted to come on the glaſs, the flow of ſap will be accelerated, and with perfect eaſe will run up veſſels ſo diminutive that to meaſure them is almoſt impoſſible.

A few of the wood-veſſels are ſeparated and run with the ſpiral veſſels to each leaf, in order to nouriſh it, as will be more particularly noticed when we come to treat of the leaf-bud.

But little of the ſap, however, paſſes off in this way from the principal current, which flows on; its chief purpoſe being to form the ſtamen and the pollen appertaining to it, and afterwards to lend its principal aid to the formation of the fruit and ſeed.

4. *The ſpiral veſſels* are a quantity of ſolid ſtrings coiled up into a ſpiral form. Mrs Ibbetſon ſuppoſes them to be formed of a leather-like ſubſtance, and, as already mentioned, to be rolled round the wood. In this ſpiral manner they run up the ſtems of trees and plants of every kind, (with a few exceptions) and from thence into every leaf and flower. Theſe ſpiral cords are ſingly too ſmall to be obſerved by the naked eye. They run into every fibre of the leaf, and are faſtened to its edges, thus croſſing among the veſſels in every direction like a ſpider's web; by which diſpoſition they can draw the leaves in any way that is neceſſary for them.

The larger of the interior wood-veſſels are each ſupplied with ſets of ten or twelve ſpiral cords, but the ſmaller of theſe have only three or four to each.

In the cabbage leaf and in the burdock, the ſpiral cords may be found in bundles almoſt as thick as a packthread, but in ſmaller leaves they are properly proportioned. Theſe ſpiral cords, Mrs Ibbetſon thinks, are the cauſe of the motions of plants. See Plant, p. 601, where theſe cords are called *air-veſſels.*

5. *Of the corona or circle of life.*—The next part to be noticed is the ſmall circle of veſſels ſituated between the wood and the pith, the importance of which, in the formation of the ſeed, will be noticed under *Impregnation of the Seed;* where are alſo related ſtrong proofs to ſhow that a plant cannot exiſt a day without the corona, and that if a young plant be deprived of this part, it will not grow again, though it will certainly do ſo if the plant be ſomewhat old. It is very curious that almoſt every botanical anatomiſt ſhould have figured this part, without giving it a name, or noticing it particularly; and that theſe anatomiſts ſhould have attributed all its powers to the pith, which, from the ſhort term of its exiſtence, and its being perpetually impeded in its progreſs to make way for the flower-bud, can evidently have but little influence. The circle of life, however, has not eſcaped the notice of Hill, who termed it the corona.

The circle of life conſiſts of rows of little cylinders which have their own peculiar juice, generally of an auſtere quality. From the corona all branches take their riſe, and from it all wood threads grow. The cylinders of which it is compoſed run up into all flower-buds, but never approach the leaf-bud as is repreſented by fig. 1 and 2.; when theſe cylinders enter the flower-bud, they make their way diſtinctly to each ſeparate flower,

Plate DXLI. Fig. 1. 2.

flower, forming the piſtil, and after depoſiting in each ſide the *line*, which is the firſt origin of life, they are afterwards impregnated, or acquire the power of giving life by the juice of the ſtamen, which runs through the ſame ſtring into the ſeed.

That the principal *vitality* of the plant reſides in the corona, we think is proved by the experiments and obſervations of Mrs Ibbetſon under *Impregnation of Seed*, and ſeems to be farther confirmed by the following remarks.

When a branch is cut from a tree, or a tree is torn up, the corona or circle of life is the firſt part that dies; and if, after a ſudden froſt, we examine the flowers of a fruit tree, we ſhall find that neither the calyx, the corolla, the ſtamina, nor the ſeeds are hurt, but that the piſtilla are deſtroyed. And if we now obſerve the piſtils with care, we ſhall ſee that it is the *line of life* which is decayed, and that this is the firſt part in which mortification commences. The peculiar liquor of the piſtil acquires a blood-red colour, and the veſſels which run up to the ſtigma become black, inſtead of their natural yellow colour.

If in wood, this line is injured (either by the decay of the bark or other means) the circle will undulate into a thouſand forms, for the purpoſe of regaining a healthy ſituation in which it may purſue its courſe.

Mrs Ibbetſon, to prove the power of the circle of life, relates the following obſervations reſpecting the *poa reptans*.

She had often meaſured in winter, ſeven or eight yards of this graſs, which appeared perfectly dead; and yet in May or June, ſhe perceived life in it at the moſt diſtant end from the ſtalk. Next ſpring ſhe took up two of theſe creeping branches which were much alike; and on diſſecting one of them through its whole length, ſhe found in it a collection of little veſſels not thicker than a very fine thread.

This collection of veſſels had run about half way the length of the branch, which was about three yards.

Mrs Ibbetſon having merely opened the cover of the graſs, laid it down again, and the little veſſels continued increaſing till they reached the end of the branch, when they made a ſtop, and it was perceived that the graſs began to thicken; and at the end neareſt the roots, the dead part became inflated with juice, loſt by degrees its dead appearance, thickened about the joints within, and at laſt ſhot forth freſh leaves and freſh roots from every joint.

Mrs Ibbetſon has ſince watched with the greateſt care, and found that the fine thread which runs through the graſs protected by the dead ſcale, was the circle of life. When this thread is ſtopped by the covers decaying, it waits till the ſeaſon permits the reſt of the plant to grow. From what has been ſaid, it is evident that the dead matter may be inflated with a living juice, and live itſelf again, provided the life near the ſtem of the plant be not extinguiſhed. Mrs Ibbetſon has obſerved this to happen in many plants, as in hydrangea, in which the ſtalks apparently lie down and are inflated again, or at leaſt a part of them.

6. *Pith.*—Linné conſidered the pith of plants as of equal importance with the ſpinal marrow of animals; but Mrs Ibbetſon thinks this part of but little conſequence, and transfers this importance to the circle of life, which ſhe compares to the brain and ſpinal marrow. She conceives that the pith forms merely a ſource of moiſture for the plant when required. The pith ſtops with every flower-bud, and begins again to grow as ſoon as the bud is paſt; it decreaſes as the ſtrength and ſize of the tree increaſe; it is the only part of the tree which is devoid of veſſels; it is merely a net, not a bundle of cylinders, and is commonly of a remarkably ſplendid or ſilver white colour.

It has been ſaid that the pith aſſumes a variety of figures, but Mrs Ibbetſon thinks this is a miſtake, though ſhe admits a few different ſorts.

All young trees and ſhrubs are provided with pith; but in the progreſs of their growth they need it no longer, the wood being a good ſubſtitute. On the ſame account, in general, we find no pith in water plants, which have a hollow ſtem, and rarely ſuffer from drought.

Linné thought that the pith was the ſeat of life and the ſource of vegetation; or in a word, the primary part of the plant. Duhamel conſidered it as of but little importance at all. Wildenow and Knight concur with Mrs Ibbetſon in regarding it as a reſervoir of moiſture for the young plants; and Dr Smith holds a medium opinion between that of Linné and the other authors juſt named.

He ſays "there is in certain reſpects an analogy between the medulla of plants, and the nervous ſyſtem of animals; it is no leſs aſſiduouſly protected than the ſpinal marrow; it is branched off and diffuſed through the plant, as nerves through the animal. Hence it is not abſurd to preſume that it may in like manner give life and vigour to the whole, though by no means, any more than nerves, the organ or ſource of nouriſhment *."

We were ſomewhat ſurpriſed to find that Mrs Ibbetſon had not particularly noticed the cellular tiſſue as a diſtinct part to be ſeen in the ſtems of trees, as it has been long known; we ſhall therefore ſubjoin a deſcription of it. It is a ſucculent cellular ſubſtance, generally of a green colour, at leaſt in the leaves and branches. Duhamel long ago called it *envellope cellulaire*, and Mirbel more lately, *tiſſue herbacé*.

Duhamel ſuppoſed that the cellular tiſſue formed the cuticle, or epidermis; but this is not very probable, as his own experiments ſhow that when the cuticle is removed, the cellular integument exfoliates, at leaſt in trees, or is thrown off in conſequence of the injury, and a new cuticle, covering a new layer of the cellular tiſſue, is formed under the old one. This ſubſtance is very univerſal, even in moſſes and ferns. Leaves conſiſt almoſt entirely of a plate of this ſubſtance, covered on each ſide by the cuticle. The ſtems and branches both of annual and perennial plants are inveſted with it; but in woody plants it is dried up, and reproduced almoſt continually, ſuch parts only having that reproductive power. The old layers remain, are puſhed outward by the new ones, and form at length the rugged dry dead covering of the old trunks of trees. The cellular integument is a part of plants of the greateſt importance; for in it the juices of plants are operated on by light, air, &c.

With regard to the branches of trees, it has been already noticed, that they derive their origin from the corona; and they are compoſed exactly of the ſame parts as the trunks from which they ariſe.

3. *The Leaves.*—Mrs Ibbetſon has, with the aſſiſtance

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* See Fig. 3. 4. and 5.

ance of the ſolar miſcroſcope, and by great attention to this natural proceſs, been enabled to give ſome new and intereſting views on this ſubject. Her opinion reſpecting the formation of the leaf-bud is, "That leaves are formed or woven by the veſſels or cotton that is generally ſuppoſed by botaniſts (to be) placed there to defend the bud from the ſeverities of winter; that theſe veſſels (or cotton) are a continuation of thoſe of the bark and inner bark in the ſtem of the plant; that theſe veſſels compoſe the various interlacing branches of the leaf, which are ſoon filled up by the concentrated and thickened juices of the inner bark, which form the pabulum of the leaf."

Mrs Ibbetſon ſays the truth of her aſſertion may be eaſily ſeen by diſſecting early buds, in which, except two or three, nothing but the cotton-like veſſels will be found. She aſks then what could be the uſe of theſe veſſels? and anſwers, that to put them within the bud to keep the outſide warm is againſt nature, for it is contrary to nature. The leaf-bud in its firſt ſtate conſiſts of two or three ſcales, incloſing a parcel of veſſels, which appear like very moiſt coarſe cotton, but when drawn out and placed in the ſolar microſcope, they ſhew themſelves to be merely the veſſels of the bark and inner bark elongated and curled up in various forms.

Theſe veſſels are of three kinds like the bark, &c. Firſt, Three or four ſhort thick ones which appear to grow from the larger veſſels of the inner bark, and through which the thickened juice flows, but with this difference, that the holes are not there.

Then there are two ſmaller-ſized veſſels, which exactly reſemble the ſmaller veſſels of the bark.

Mrs Ibbetſon has always found the ſhort thick kind of veſſels to form the mid-rib of the leaves, and the ſmaller-ſized veſſels to compoſe the interlacing fibres (or veſſels) of the other parts of the leaves; and from often comparing the full grown leaf with the leaf of the bud, ſhe feels the moſt thorough conviction that the latter takes its origin as above noticed. The pabulum of the leaf which lies between the veſſels, is compoſed of that thick juice which runs in the bark or inner bark of the tree, and which does not exiſt in any other part of it. The pabulum differs eſſentially from the ſap, and may be called the blood of the tree, as it poſſeſſes peculiar properties in different trees; thus it is of a gummy nature in one, of a reſinous in a ſecond, and of an oily nature in a third, &c.

Mrs Ibbetſon is not certain whether the pabulum both flows forwards and in a retrograde direction; but ſhe is convinced that the greateſt part of it is taken up in forming the leaves. The pabulum of the leaf, after the veſſels are arranged and croſſed, grows over in bladders, making alternate layers with the ſmaller pipes (veſſels), and with the branches of the leaf.

Mrs Ibbetſon ſtates, that ſhe does not know any tree which gives a more convincing proof of the formation of the leaves in the bud, than may be ſeen in the horſe cheſnut (*æſculus hippocaſtanum*) about the month of November or December.

Several different mid-ribs may be taken out at once from the ſame leaf-bud, which have an innumerable number of extremely fine ſilken veſſels faſtened to or growing up from each ſide of them. When theſe veſſels have become ſufficiently interlaced with each other, the pabulum will begin to grow over them, in form of ſmall bladders full of a watery-juice; and then larger veſſels will croſs over them, which will ſoon be followed by another row of bladders, and a ſimilar proceſs will go on until the leaf has attained its proper thickneſs. The leaves thus formed are very ſmall, but when once their ſhape is completed every part of them continues to increaſe in ſize. Fig. 6. repreſents the leaf-bud of the horſe-cheſnut, as it was examined by Mrs Ibbetſon about the month of January.

Fig. 6.

Mrs Ibbetſon next notices the arrangement of the leaves in the buds of different trees; but we ſhall conſider them by and bye.

The rolling, folding, or plaiting, &c. of the leaf-bud, it is obſerved, does not merely take place at once; but to complete the proceſs of budding, it appears that this arrangement of the leaves is repeated ſeveral times. During this arrangement the bud-leaves are immerſed in the glutinous liquor which runs in the bark (and forms the pabulum); and the preſſure of the leaves is very great. By this preſſure and the rolling, &c. the leaves are completed; for if a leaf be taken from the bud before this proceſs commences, it may be compared to a piece of cloth before it is dreſſed; for its back will be obſcured by the ends of veſſels, which, had it remained *in ſitu*, would have been all rubbed off, except the hairs which remain on many plants.

We come now to the formation of the edge of the leaf, a curious and beautiful proceſs.

The bud if opened will appear full of the glutinous liquor which forms the pabulum, and the leaves arranged in the manner proper to the particular tree from which the bud is taken. If one of the leaves be taken out, the edges (in whatever manner folded) will exhibit a perfect double row of bubbles, following the ſcollop of the edge of the leaf; and it will appear as if it were ſet with brilliants.

Things being in this ſtate, all that is wanting for the completion of the leaf is the formation of the pores, now to be mentioned. Mrs Ibbetſon ſtates that in many hundred *forming leaves* which ſhe expoſed to the ſolar microſcope, ſhe had never once been able to ſee the pores; which ſhe has often obſerved after the leaves have completely quitted the bud; and ſhe is uncertain whether this is owing to the greater thickneſs of the young leaf, and its being covered with more hairs than it is afterwards, which obſcure or conceal the pores; or whether it be cauſed by the upper net-work of the leaf growing laſt. While the upper and under cuticles of the leaf are growing, the edge of it is completing; for the bubbles generally divide, and partly dry up, leaving horny points in their ſtead. When the edges of the leaves are completely formed, they burſt from the bud and aſſume a different aſpect.

The veſſels of the leaves (thoſe confined within the mid ribs and ſide ribs of the leaves) are of two ſorts, the ſpiral, and the nouriſhing. The ſpiral veſſels are thoſe corkſcrew-like wires which ſurround the two laſt rows of the ſap veſſels. The nouriſhing veſſels are the only parts formed of the wood. They convey the ſap neceſſary for the ſupport of the leaves, and run on each ſide of the ſpiral veſſels.

To prove that ſhe has given a fair and accurate account of the formation of the leaf, Mrs Ibbetſon adds the following remarks. The colour of leaves, ſhe obſerves, is not to be found in their ſubſtance, but in the liquid with which it is filled. The darkeſt green leaf that can be procured, has both its upper and under cuticles of a perfect white colour. In the cuticle the pores are to be found.

A leaf has rather a thicker net below than it has above; but this does not ſufficiently account for the varieties of tints in different leaves.

The under net (or cuticle) does not lie ſo cloſe to the pabulum of the leaf as the upper one; which may account for the colour not piercing ſo much through. When the two nets (or cuticles) are taken off, then the pabulum of the leaf appears.

The pabulum is formed of little bladders, filled with a dark-green liquid, and interlaced with veſſels. When the pabulum is removed, a bed of large veſſels preſents itſelf; then a collection of bladders; which is followed by the larger lines (or veins) of the leaf. We next meet with another bed of bladders, which is covered by the under cuticle. Though the bladders differ in ſize and colour as well as in thickneſs in different leaves, yet the general arrangement is the ſame in moſt plants; but there are exceptions, as the firs, graſſes, or thoſe graſſy leaves of early ſpring, which we have in the iris, crocus, ſnow-drop, &c. for their leaves are of a different nature.

But we ſhall now refer to the figures, which will ſerve to illuſtrate the mode of formation, &c. of the leaf-bud.

Fig. 7. 8. 9. Fig. 7. 8. 9. exhibit the commencement of the formation and growth of leaves; *a*, *a*, *a*, *a*, the mid rib;
b, *b*, *b*, the young veſſels appearing like cotton; *c*, *c*, the
ſpiral nerves; *d*, the ſmaller veſſels croſſing each other.
Fig. 10. Fig. 10. ſhews the formation of the pabulum; *e*, *e*, the
fine veſſels growing up each ſide of the mid rib; *f*, the
Fig. 11. pabulum. Fig. 11. bud of the lime-tree (*tilia Europea*).

4. *Of the* FLOWERS, *including the calyx, corolla, ſtamina, and piſtillum.*—Linné long ago expreſſed his opinion that each of theſe parts was formed from a particular part of the ſtem; thus the calyx was formed by the bark, the corolla by the inner bark, the ſtamina by the wood, and the piſtilla by the pith. Linné alſo reckoned the pith of a plant (which he conſidered to be of equal importance with the ſpinal marrow of animals), as the ſole formative organ of the whole vegetable kingdom.

Linné's idea reſpecting the formation of the calyx, corolla, &c. has been often refuted; but Mrs Ibbetſon comes forward to defend the opinion of the illuſtrious author with a little modification. She does not, as already noticed, conſider the pith as of great importance; ſhe therefore ſays, that the corona or circle of life forms the piſtil, not the pith; and thinks that each part of the ſtem has, when it arrives near the flower ſtalk, its peculiar juice.

Mrs. Ibbetſon, as a ſtrong proof that the circle of life forms the piſtil, ſays that it is to be found in all theſe leaves that bear the flower either on the middle or on their ſide; but in no other leaves.

She firſt obſerved this in the butcher's broom, where this circle leads directly up to the flower; then in ſcolopendrums, and afterwards in xylophyllos.

The leaves of ſuch plants are more woody than any others, as every one may know on breaking them. In ſuch plants alſo, the circle of life may be traced as leading from one flower to another.

Mrs Ibbetſon alſo thinks that all thoſe parts which concur in forming the flower alſo join in forming the fruit and ſeed.

Mrs Ibbetſon then adverts to the opinion of Wildenow, when he ſays, "we find in the ſpringing flower, elongations of air-veſſels, but we never ſee the elongations from each particular part, one forming the future calyx, another the corolla, and ſo forth." "For inſtance, in the common ſun-flower (*helianthus annuus*), where in an immenſe large receptacle, numerous ſmall flowers are placed, how ſhould theſe elongations be able to unfold themſelves into florets from the bark, inner bark, &c. through ſuch a receptacle? There would ariſe a confuſion amongſt theſe ſmall parts which is never met with."

"How ſhould, beſides, the ſtamina be formed in herbs, which are not ligneous, or the piſtil in plants which have no pith? Every one may thus eaſily conceive that all theſe opinions are mere hypotheſes, which may be refuted, even without the aid of anatomical diſſection."

Mrs Ibbetſon attacks Wildenow's opinion, and ſays that he adduces the ſyngeneſian claſs to prove the accuracy of it, the claſs which contains the very plants that would have proved the miſtake of his argument, had he diſſected them.

Mrs Ibbetſon then propoſes the following queſtions to Wildenow. Why, if the nouriſhment of each part of the ſtem be not confined to each different part of the flower, does the whole arrangement of the parts *alter*, the moment it gets to the flower-ſtalk.

Why are there particular veſſels to confine and carry the juice to each peculiar part, if it were not of conſequence that this juice ſhould touch no other places? For what purpoſe is the curious and artificial management in the bottom and top of a ſeed-veſſel, which enables the diſſector to ſay, that "there are five diviſions of little veſſels proceeding from the wood; I know, therefore (though I do not ſee it), that this muſt be a pentandrian flower; here is but one middle veſſel proceeding from the circle of life (for the pith ſtops), it is therefore of the order monogynia; here are five diviſions of little veſſels proceeding from the inner bark, it muſt therefore have five petals?" Mrs Ibbetſon wiſhes others to be convinced of theſe facts as well as herſelf. If a cut be made above or below the ſeed-veſſel of a lily, a violet, or a tulip, ſhe thinks conviction of her accuracy will follow. Why in cutting above or below the ſeed-veſſel of a ſyngeneſian flower can you directly tell, whether it belong to the order ſuperflua, æqualis, or ſegregata? Look at the bottom of the ſeed-veſſel of the *ſonchus*; every *pin-hole* of the veſſel of the male is carried up by correſponding veſſels in the outward cuticle of the ſeed till it meets and joins the *ligature of the males*; and the female liquor is protruded through the inſide of the ſeed, and is perhaps one of the ſtrongeſt proofs of the impregnation of the female. In the ſyngeneſian claſs (ſee fig. 12.), the delicacy of the veſſels, which may be ſuppoſed too ſmall for a liquid to flow through them, muſt not impede the belief that it does ſo, when we conſider the circulation of blood in the diminutive animal that torments the body of the flea or louſe. Mrs Ibbetſon ſays ſhe has ſeen the liquor run up with the utmoſt celerity through the upper cuticle of a very ſmall ſeed of a plant belonging to the ſyngeneſian claſs, till it met the male and continued its courſe. It is to be underſtood that the juice from the corolla flows in the reſt of the cuticle, and that the largeſt veſſels are thoſe for the *male liquor*. See fig. 12. 13.

Fig. 12. 13.

II. PHYSIOLOGY OF PLANTS.—In treating this part of the ſubject, we propoſe to conſider, firſt, the impregnation of ſeeds, and, ſecond, the irritability of vegetables.

1. *The impregnation of the ſeed.*—The inveſtigation of what is included under this title, forms one of the moſt beautiful and intereſting purſuits of the vegetable phyſiologiſt. Mrs Ibbetſon has communicated ſome curious obſervations on this ſubject. Provided with a powerful ſolar microſcope for opaque objects, ſhe proceeds to an examination of the ſeed, and the firſt ſhooting of the infant plant, or rather of the germ or veſſel which precedes it; and ſhe remarks that it is almoſt impoſſible to aſcertain the exact time when the ſeed is firſt formed in the pericarp; but that ſhe has always found it in the winter buds when they were large enough for diſſection.

It is curious to obſerve the veſſels, which, ſhe ſays, may properly be called the life, tracing their way to each flower-bud; for a ſeed may be ſaid to depend for perfection on two *ſeparate moments*: the one in which the life *firſt enters the ſeed*, when the whole outward form appears to be perfected; and the ſecond, when the impregnation of the ſeed takes place, by the ripening of the pollen.

But when the life enters, it leaves a little ſtring, and remains for a long time afterwards in a torpid ſtate. This ſtring croſſes the corculum, or heart of the ſeed, ſo called becauſe it is the cradle of the infant plant. She then ſtates that the ſeed is attached to the ſeed-veſſel by two diſtinct organs, termed by the firſt botaniſts the umbilical cord, but as ſhe thinks improperly, ſince they do not convey nouriſhment to the infant plant, which is wholly the office of the ſecond ſet of veſſels. We cannot agree with Mrs Ibbetſon in her opinion; for although the umbilical cord of an infant contains nouriſhing veſſels, it alſo contains nerves, and yet we would never think of reſtricting this term alone to the arteries. The firſt of the connecting organs Mrs Ibbetſon conceives to be the circle of life, firſt, becauſe without it the plant dies, and, ſecond, becauſe although every other part be eradicated by degrees and the circle of life be uninjured, the plant will grow again.

She has made theſe experiments many thouſand times and with the above reſults. The circle of life conſiſts of delicate ſimple veſſels, which carry a juice of a particular nature, and may be traced in every part lying between the wood and the pith. Theſe veſſels are not to be found in the leaf-bud; for they paſs by it to the female flower, where they eſtabliſh a new life in the ſeed: a life which will enable it to grow, but not to give life without impregnation. Theſe veſſels are the life, therefore, from which all flower-branches grow and all root-threads proceed. In calling theſe veſſels the circle of life, Mrs Ibbetſon ſays ſhe only expreſſes what its office ſeems to denote.

Mrs Ibbetſon goes on to deſcribe the next (or ſecond) organ by which the ſeed is attached to the ſeed-veſſel. It conſiſts of the nouriſhing veſſels, which ſhe is inclined to think proceed from the inner bark; at leaſt they may certainly be traced thence after the infant plant has left the ſeed. When introduced, they enter not the ſeed at the ſame place as the life does; they come not into the corculum, but paſs it, and ſpread themſelves over a ſmall ſpot below it, which is viſibly of a different nature from the reſt of the ſeed. In farinaceous plants this ſpot is yellow and yields a milk-white juice; but in other ſeeds it is white, and gives a glutinous water of a ſweetiſh taſte. Mrs Ibbetſon thinks it probable that the nouriſhing veſſels come from the fruit *filled with this juice*, which medicated with that part of the ſeed (which very apparently diſſolves), they together form a nouriſhment ſuited to the infant plant. When the ſeed is ſo far perfected, it remains in an almoſt torpid ſtate, or growing very little; while the flower expands daily, and the ſtamens are haſtily advancing to their perfect ſtate.

It is now that by an almoſt imperceptible contraction of the lower part ot the piſtil, the juice is raiſed to the ſtigma (A) on which it may be ſeen hanging in a large glutinous drop, which never falls off. As ſoon, however, as the mid-day heat abates, this juice, which is peculiar to the piſtil, retires again within the tube, the contraction ceaſing with the heat that cauſed it. The ſame proceſs goes on daily, till the ſtamina are ripe and ready to give out their interior powder to the piſtil, which is always ſo placed as to receive the greater part of it; and as the anther (B) requires only moiſture to burſt it, it ſoon yields that fine and imperceptible duſt, which quickly *melting and mixing with the before-mentioned liquid*, forms a combination of ſo *powerful* and *ſtimulating* a quality, that it no ſooner runs down the interior of the ſtyle, and touches the nerve of life in the heart of the ſeed, than this veſſel ſhoots forth in the moſt ſurpriſing degree, forming directly a ſpecies of *circular hook* within *the void;* which in leſs than two days is often completely filled, though it had perhaps for many weeks before lain in an abſolute torpor. This circular nerve is ſoon covered by an excreſcence that hides it; but if the corculum be divided with a fine lancet, the circular hook is diſcoverable, until the young plant is near leaving its cradle or ſeed. At the turn of the hook the cotyledons grow, and the root ſhoots from the covered end. The plant may be now ſaid to lie in the ſeed in a contrary direction from that in which it will at a future time grow, ſince the root is above, and the ſtem below: but nature has provided for their change of place, ſince it is effected as they leave the ſeed. It has been already noticed that the nouriſhment of the infant plant

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(A) In the journal it is ſaid "to the pointal;" but certainly ſtigma is meant, for piſtil and pointal are ſynonymous.

(B) In the journal it is called pollen, but anther muſt be meant.

plant is medicated between the juice brought in the nouriſhing veſſels, and the peculiar ſpot in the ſeed, forming a liquid which continues to abound; indeed the infant plant may be ſaid to *repoſe in it*, till the root has opened the whole or part of the ſeed. The root then changes its direction, and runs into the earth, ſoon forming a number of ſtringy hairs, which ſerve as ſo many ſuckers to draw the liquid nouriſhment from the earth, while the plant quickly ſhews, by the rapid progreſs it makes, the advantage it receives from its change of diet; for it ſoon raiſes itſelf from its proſtrate poſture, emerges from the ſeed, and is now ſeen in its proper direction. The above account, we think Mrs Ibbetſon juſtly remarks, affords a complete confirmation of the ſexual ſyſtem.

In the ſyngeneſian orders, the piſtil being moſtly ſingle, runs up from the ſeed; and the juice of the piſtil has no other way of reaching the pointal (ſtigma muſt be here meant), but by paſſing through the ſeed, which it does without producing any effect, or filling up the vacancy at the top of the corculum. But as ſoon as the juice of the piſtil becomes mixed with the pollen, which diſſolves in it, the void of the corculum is filled, the hook is ſoon afterwards formed, and the plant is rouſed to life. Mrs Ibbetſon relates ſome experiments which ſhe made to aſcertain whether the umbilical cord was, or was not, the life of the plant. She placed a bean in the earth, and when the infant plant was ready to leave the ſeed ſhe opened it with a fine lancet, and cut off the cotyledons, juſt where they join the heart and the circular hook which have been before deſcribed. She then tied a piece of very fine thread round the bean, and replaced it in the earth. The cotyledons grew again, though higher up, but they appeared very weak and ſickly for ſome time. She cut off the root of another bean which had been placed in the earth, and which was of the ſame age as the above, and found that the root grew again in a few days and appeared quite healthy.

In a third experiment ſhe ſeparated and cut off the nouriſhing veſſels from each ſide of the bean; but a great number of hairs grew from the wounded part, which, by attaining moiſture from the earth for nouriſhment, ſupplied the place of the veſſels cut off; ſo that it was not aſcertained whether or not the bean would live independent of theſe veſſels, which was the object of the experiment. We obſerve here, however, a grand proviſion of nature for the embryo plant: hairs being formed to ſupply it with moiſture when the nouriſhing veſſels are deſtroyed. Mrs Ibbetſon next took a bean which had been about four days in the earth, and opening it with great care took out with a fine lancet the part which ſhe eſteems the cord of life, that is the part which croſſes the corculum and ſhot forth on the firſt Fig. 14. 15. impregnation of the plant. *oo*, fig. 14. and 15. repreſent the nouriſhing veſſels of a bean; L to *n* two ſeminal leaves or cotyledons; *ll* the cord of life, which is more eaſily ſeen in the ſeed of the lily, fig. 15. *ll* croſſing the empty part of the corculum. Mrs Ibbetſon took a flower of the lilium genus, as having a large veſſel eaſily attained; and being careful not to ſeparate it from the nouriſhing veſſels, ſhe divided the line of life fig. 16. *ll*, cutting each thread between the ſeeds, and ſo cutting off their communication; but did not touch *o o*, which ſhe thinks is the nouriſhing veſſel.

The conſequence was, that the ſeeds of this flower were never impregnated. Mrs Ibbetſon next tried the effect of taking the nerve of life from the cheſnut, the walnut, acorn, &c.; firſt opening a ſeed without touching the nerve, that ſhe might be certain that the opening was not the cauſe of its death. Fig. 17. repreſents the Fig. 17. heart taken out of a ſeed of the cheſnut; *l* is the circular hook already deſcribed; *o o* the nouriſhing veſſels, and *l l* the line of life, which was taken out from ſome ſeeds where it croſſes the heart at *m*. Fig. 18. is the Fig. 18. ſeed of the gooſeberry; *o* the nouriſhing veſſels, *e* the line of life, and *m* the corculum or heart.

She found that all thoſe ſeeds from which ſhe took the nerve of life died; and that the others, which had been merely laid open, lived. She remarks that it is only at the beginning of life, that the plant can be killed by this proceſs; for when older, if the nerves of life decay, they ſhoot out above the declining part, and run into any part of the ſtem that is pure, to preſerve themſelves. Mrs Ibbetſon then ſtates that this nerve is the ſource of life in very decayed trees; and is alſo the cauſe of a double pith, or at leaſt the appearance of it, in many trees.

To obſerve this line of life, ſeeds muſt be examined in their firſt formation; for when it has done its office, it detaches itſelf. When the ſeed is boiled, the line of life and nouriſhing veſſels mark themſelves by becoming of a dark colour.

2. *Irritability of vegetables.*—In entering upon this ſubject, we ought to warn our readers, that very oppoſite opinions have been entertained reſpecting it; ſome phyſiologiſts of the greateſt eminence allowing that we have ſatisfactory proofs of the irritability of vegetables in a variety of plants, but more particularly in the motions of the mimoſæ, dionea, &c.; while others of no leſs reſpectability aſcribe theſe motions to the influence of light, heat, or ſome other mechanical agent.

As neither muſcles nor nerves have ever been demonſtrated in the vegetable ſtructure, of courſe the proofs of the irritability of vegetables are drawn from the intimate analogy which ſeems to exiſt between the motions of ſome plants and thoſe of animals. Some phyſiologiſts, from obſerving the ſimilarity of motions in the two kingdoms, were naturally led to aſcribe them to the ſame cauſe; others, from not being able to obſerve the ſame motive organs, namely, muſcles, in both kingdoms, denied that plants could poſſeſs irritability; a third ſet, waving the idea of irritability in the vegetable kingdom, have laboured to ſhew that the motions of plants depend on mechanical cauſes alone.

We ſhall firſt notice the obſervations of Mrs Ibbetſon, who aſcribes the motions of plants to the ſpiral wires which we have deſcribed. Her opinion is founded upon a number of new obſervations made with the ſolar microſcope, which we ſhall proceed to relate.

1ſt, The ſpiral veſſels are not to be found in any plants to which motion is unneceſſary.

She could not obſerve theſe veſſels in any of the firs, in any of the plants which ſpread their leaves upon the ſurface of the water, in any of the ſea weeds (c), of the lichens, or of the graſſes; and ſhe does not think that

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(c) She afterwards excepts the *confervæ*, which have motion.

that they exiſt in the ſcolopendrums or lemnas. We would here obſerve that if theſe obſervations were completely true, they would certainly afford a ſtrong proof in confirmation of her opinion; but we ſuſpect that they are not altogether juſt, eſpecially as we obſerve a diſcrepancy in the papers of Mrs Ibbetſon. Thus at one part ſhe has given us a very minute deſcription of the ſpiral veſſels in the runners of the *poa reptans*, and now ſhe ſays they are not to be found in the graſſes (D).

Mrs Ibbetſon's ſecond argument is, that if a plant whoſe leaves preſent their faces to the light, be turned ſo that the backs are to the ſun, the leaves in a few hours will regain their former poſition; but if this be often repeated, although the plant will not ſuffer, yet the leaves will be longer at every repetition in returning to their former ſituation, or will ceaſe to move at all. She accounts for this by ſaying, that the ſpiral-like elaſtic veſſels are relaxed by the operation, and loſe their power of coiling into their uſual form.

Others would account for the above fact by ſaying that the irritability of the plant was exhauſted by theſe repeated and unnatural actions; in the ſame manner as the mimoſa becomes gradually leſs ſenſible to impreſſions when too often renewed.

Mrs Ibbetſon's third argument is, that thoſe leaves which have moſt motion, are provided with moſt ſpiral veſſels, and have theſe veſſels moſt twiſted; as in the *populus tremula*.

Fourth proof. Mrs Ibbetſon divided the ſpiral veſſels of a vine leaf while growing, without touching the nouriſhing veſſels; and from that moment it never contracted, and when placed with its back to the light, it did not alter its poſition, though it was long before it decayed. Both electricity and galvaniſm cauſe theſe leaves to contract, by affecting the ſpiral wires (not the cuticle), for when the leaf is deprived of theſe veſſels it does not contract at all.

We would here remark that we ſuſpect much, in the above experiment, that more than the ſpiral veſſels was divided: at any rate there is very great diſcordance between Mrs Ibbetſon's experiments and that of M. Calandrini, who found that vine leaves turned to the light when they were ſeparated from the ſtem and ſuſpended by a thread.

Fifth argument. Mrs Ibbetſon obſerved, when ſhe placed ſome of the ſpiral veſſels taken from a cabbage leaf upon one end of a long netting needle, and cauſed a candle to approach, that they were much agitated, and at laſt flung themſelves off the needle. We think no concluſion can be drawn from what is here ſtated.

The freſh water *conferva* and the dodder tribe, are the only plants, without leaves, that Mrs Ibbetſon is acquainted with, which have ſpiral veſſels.

Mrs Ibbetſon ſays that the ſpiral veſſels are ſo very tough, and ſo very tightly coiled, in the leaf ſtem (*petiole*) of the *geranium cordifolium*, that ſhe has by means of them been enabled to draw up the leaf; but it is difficult to be done.

The ſixth proof is drawn from the effect produced by moiſture on Captain Kater's hygrometer, which will be noticed ſoon.

General Obſervations.—Mrs Ibbetſon ſays the ſpiral wires may be conſidered as a ſecondary cauſe of motion, as they are primarily acted upon by light and moiſture. By means of the ſpiral wire, all the movements of plants are made; by it, flowers open in the morning and ſhut in the evening; the leaves turn, and the creeping plants wind in their regular order. Mrs Ibbetſon ſays the opening of the flower at a different time of the day, or its turning in a different manner, does not militate againſt the above ſtatement; as ſtrong light and dry weather produce a contraction of the wire, while darkneſs and moiſture effect a dilatation of it. It depends wholly upon the poſition in which the ſpiral wire is placed, whether by its dilatation the flowers ſhall be opened or ſhut, as in mechanics the ſame ſpring may be made to turn to the right or to the left, to open or to ſhut a box. Moſt of the flowers which Mrs Ibbetſon has obſerved to cloſe at noon, have an extremely limber corolla, formed only of a double cuticle without pabulum; and hence they are ſoon overcome by heat, and relaxation directly takes place; as in the *convolvulus nil*, the evening or tree primroſe, &c.

We muſt add, however, that we regard this account of the ſpiral veſſels with ſome degree of doubt. We ſuſpect that the ſpiral veſſels, if they have the power of opening or ſhutting a flower, will always act in one uniform manner; i. e. if they are able to open it, they will always do ſo, and *vice verſa*.

The *nymphea alba* raiſes itſelf out of the water, and expands, about ſeven o'clock in the morning; and cloſes again, repoſing upon the ſurface, about four in the evening. Now its petals are much thicker than thoſe of the *leontodon taraxacum*, which ſhuts up its flowers between eight and nine in the evening.

We could multiply inſtances; but we conceive we have ſaid enough to ſhew, that the flowers with the moſt ſlender corolla are not uniformly thoſe which ſooneſt cloſe.

Mrs Ibbetſon ſays, contrary to the opinion of Mirbel, that the caſe in which the ſpiral veſſels are incloſed is capable of being ſtretched; indeed it is formed of ſo thin (or rather ſo looſe) a ſubſtance, as plainly to be intended to dilate and contract. The caſe is compoſed of a very few thin veſſels, interlaced with an extremely fine ſpiral wire; while the larger ſpiral veſſels fill up the caſe in an irregular manner, the nouriſhing veſſels form a regular circle of tubes around it. See fig. 29. and 30.

Of the Indian graſs (*andropogon contortum* of Linné), of which Captain Kater's hygrometer is formed.—The chief part of it is made with the ſpiral awn of an Indian graſs, which readily untwiſts in a moiſt atmoſphere, and *vice verſa*. Now Mrs Ibbetſon aſks, if the moſt trifling change of moiſture can untwiſt one ſort of vegetable fibre, and by this means manage an inſtrument, why ſhould not a quantity of ſimilar formed fibres or ſpiral veſſels produce the ſame effect on leaves and flowers? She ſays, Captain Kater's hygrometer moves very ſenſibly if a finger be placed within half an inch of the fibre (awn). Now, the moſt ſenſitive plant we have will not move but with the touch."

We are quite aware of the effects of moiſture on ſome vegetables.

(D) She found the ſpiral veſſels alſo in the *andropogon contortum*.

vegetables. We have ſtrong proofs of it in ſome of the moſſes, as in the *bryum hygrometricum*, which, if the fruitſtalk be moiſtened at the bottom, makes three or four revolutions; if the upper part be moiſtened it turns the contrary way.

We can ſcarcely compare theſe motions with thoſe of the mimoſæ; for it is quite evident that they are produced by moiſture: but as we are to ſpeak of the motions of the mimoſæ in a little, we would only obſerve, that when Mrs Ibbetſon ſays "the ſenſitive plant will not move but with the touch," ſhe argues againſt herſelf; for this ſhews that it is acted upon by the ſame cauſes as animal muſcles, and that it is not governed by moiſture alone.

The only ſenſitive part of the Indian graſs is the awn, which is formed of a leather-like ſubſtance, infinitely thicker and ſtronger than the uſual ſpiral veſſels in plants. The awn is formed of two apparently flat pieces, with a cylindric hollow running through the middle, which is filled with a thick ſpiral wire. Fig. 21. 22. 23. and 24. Each ſide of the awn is briſtled; but the briſtles do not add to its ſenſibility.

Of the Nettle.—The awn or ſting of the nettle is a long pipe with a bag at the end, divided into two parts; the ſmaller contains the poiſon, and the larger is ſituated below it. This bag ſeems alſo to be compoſed of a leather-like ſubſtance, and is likewiſe affected by light and moiſture.

The moment the upper part of the pipe is touched, the under part of the bag whirls up, breaks the poiſon bladder, and throws its contents violently up the pipe, burning the perſon who touches it.

Light thrown upon the bag by means of the ſolar microſcope, produces the ſame effect as touching it. The poiſonous liquor is protruded up the pipe with great force, till it iſſues out at the minute aperture at the point; but before it does ſo, the pipe is bent down with a jerk, by means of the ſpiral wire.

The ſpiral wire winds round the bag at the bottom of the pipe; and it is by the action of this wire that the bag is made to contract. The nettle lays down its ſtings every evening, juſt as the ſenſitive plant does its branches. See fig. 19, and 20.

Mimoſa Senſitiva.—The motions of this plant are regulated not only by the ſpiral wire, but alſo by a bag of a leather-like ſubſtance, which is capable of contraction and dilatation.

We ſhall next give Mrs Ibbetſon's plate reſpecting the ſtructure of this plant, with her deſcription.

Fig. 25. Fig. 25. is a repreſentation of the ſprings which govern each leaf; *d*, *d* is the ſtalk. Each leaf has a baſe *c*, *c*, which ſerves to concentrate the ſpiral wires. Theſe paſſing over in every direction, being drawn through the narroweſt parts of the ſtem *b b b b*, preſs the ſtem together; and, when touched, lay the leaves, one on the other, the whole way down the leaf-ſtalk. But, before the ſtimulus is applied, the ſtem is flattened in a contrary direction. The ball of the leaf is hollow, and filled with oil. The parts *e e* and *p p* (fig. 26.) are made of that leathery ſubſtance, which forms the cuticle, and is contracted by the light in the ſolar microſcope. The parts *e e* contain the oil which ſerves to lubricate the knots (we ſuppoſe), and enable them to ſlip over each other; beſide, probably, acting ſome important part in the formation of the various gaſſes and juices in the compoſition of the plant. Fig. 26.

When touched, the whole ſtring relaxes at *o o*, and lets the branch fall. This it would alſo do at *m*, if it were not ſupported by the wood-veſſels turning into the leaf. Fig. 27. is the part *e e p p* uncut, and in its natural ſtate. Mrs Ibbetſon thinks that not only the motions of this plant, but of all others, depend upon the ſpiral wires which contract and dilate by the action of light and moiſture. She adds, that there are no ſpiral wires in the ſeminal leaves of the *mimoſa ſenſitiva*, and that the ſeminal leaves have no motion whatever.

In farther illuſtration of this ſubject, we ſhall next preſent our readers with ſome obſervations by Mr Lyall, lately publiſhed in Nicholſon's Journal *, reſpecting the irritability of the *mimoſa pudica*, and ſome other plants.

"It is well known (he obſerves), if we take a leaf of this plant, ſimilar to what is repreſented (fig. 31.), and then, by means of a pair of ſciſſars (completely dry), cut off half the pinnula A, this pinnula will contract at its joint, either immediately, or in a few ſeconds; its neighbour, or oppoſite pinnula, B, cloſing at the ſame time, or ſoon after.

"The pinnulæ A and B having come into contact, there is a pauſe, or a ſhort ceſſation, of motion; but in the courſe of a few more ſeconds, the next pair of pinnulæ, CC, will alſo ſhut up, and the ſame will happen with every pair of pinnulæ of that pinna ſucceſſively; only with this difference, that the intervals between the ſhutting up of each pair of pinnulæ will be ſhorter, the farther it is from the pinnula that was cut. After the whole of the pinnulæ of this pinna have completely cloſed, and a little interval, then the joint D will bend ſo as to allow the pinna to drop conſiderably.

"Nevertheleſs, the motion is often not ſo obvious in this joint, as in that to be mentioned.

"A longer pauſe will now intervene, in ſome caſes ſo long as to make us ſuppoſe that all motion is at an end; but at length the joint E ſuddenly bends, and aſtoniſhes the beholder.

"The petiole F now, inſtead of forming an acute angle with the ſtem above the joint, forms a very obtuſe angle with it.

"We ſhall now have another ceſſation of motion, and then the joint, H, will ſlightly bend; then another pauſe, then a ſhutting up of the pair of pinnulæ, II, and ſo on with the other pinnulæ, till the whole pinna is cloſed. The motions, however, will not be ſo regular in this pinna as they were in the other; for as the pinnulæ II approach, they preſs forward the next pair, and ſo on with all the reſt."

Theſe motions, the author ſuppoſes, are not occaſioned by impulſe; for a bit of the pinnula may be cut off almoſt without producing any motion.

But, allowing that a little motion were produced, it comes naturally as a queſtion, Why does the motion become ſo extenſive? how is the impulſe communicated to the origin of the petiole? The author does not think that theſe queſtions will ever be ſatisfactorily anſwered upon mechanical principles.

He admits indeed, that a ſtructure exiſts in the *mimoſa ſenſitiva*, correſponding to what Mrs Ibbetſon has deſcribed

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* Vol. xxv. 92.

deſcribed; although he ſeems to have ſome doubts reſpecting it. He then proceeds to inquire, whether by ſuch a ſtructure, acted upon by heat, light, or moiſture, we could poſſibly explain the motions of the *mimoſa pudica*. "On the experiments above related, (he obſerves), I preſume no one would ſay, that moiſture was the cauſe of motion, as the ſciſſars were quite dry."

It is to be remembered alſo, that this plant will perform its motions under water.

As there was no change of light, conſequently this had no ſhare in the effect. Beſides, when moiſture is produced (Mr Lyall certainly means darkneſs) in conſequence of the abſtraction of light, all the pinnulæ ſhut up at the ſame time; not, however, in the regular order mentioned in the experiment. Neither does the motion take place from change of temperature, for the temperature was not altered.

A great many queſtions will here ſuggeſt themſelves, as, How does it happen that the motion is produced? how does it become ſo extenſive? how comes it that there are regular motions and pauſes, &c.?

The author concludes, by ſaying, that it is vain to attempt any mechanical ſolution of the phenomenon mentioned above, "which would ſeem to depend on an exquiſite irritability in the plant itſelf."

Dionæa Muſcipula.—Mr Lyall does not think that the motions of this plant are to be explained in the manner ſpoken of by Brouſſonet, who aſcribed them to an evacuation of a fluid from the leaf, which will be noticed when we ſpeak of the *droſeræ*. For the leaf may be touched without cauſing any efflux of fluid whatever, and yet it will contract completely.

Comparetti's explanation reſpecting the motion of this plant is not admitted; becauſe it ſeems improbable, is contrary to analogy, and inadequate to explain the phenomenon.

Of the Droſera Longifolia and Rotundifolia.—As many of the muſcles of the animal ſyſtem, as the heart, diaphragm, &c. act quite independent of the will, and as theſe parts are highly irritable, Mr Lyall wiſhes to ſhow, that a voluntary command of a muſcular force ſhould not be taken into the definition of the word irritability, as has been done by ſome. Mr Lyall ſays, "By irritability, I underſtand, that property inherent in ſome bodies (or rather parts of bodies), by which, when a ſtimulus is applied, they are enabled to contract.

The leaves of the droſera rotundifolia, when properly unfolded, lie round the ſtem in a ſtellated manner. The footſtalks of the leaves vary in length from half an inch to an inch and a half. The leaves are covered on their upper ſurface by a number of hairs, varying alſo in length from one line to three-eighths of an inch, and are each terminated by a little gland, which gland is covered by a tranſparent viſcid fluid, preſenting a fine appearance.

The chief difference between the droſera longifolia and rotundifolia is in the ſhape of the leaves; thoſe of the former being obovate, while thoſe of the latter are of an orbicular ſhape.

Mr Lyall mentions the obſervations of Mr Whately, who, it would appear, was the firſt in this kingdom who deſcribed the contractions of the droſeræ when irritated.

Mr Whately and Mr Gardom had obſerved ſome inſects impriſoned in the leaves of this plant, and hence were led to preſs with a pin the centre of other leaves in their natural and expanded form, when they very ſuddenly contracted, and, as it were, encircled the pin.

Roth had noticed, in 1779, that the leaves of the droſeræ moved, when irritated. He placed an ant upon the middle of a leaf of the droſera rotundifolia, but ſo as not to diſturb the plant. The ant endeavoured to eſcape, but was held faſt by the clammy juice at the points of the hairs, which was drawn out by its feet into fine threads; in ſome minutes the ſhort hairs on the diſk of the leaf began to bend, then the long hairs, and laid themſelves upon the inſect. After a while the leaf itſelf began to bend, and in ſome hours the end of the leaf was ſo bent inwards as to touch the baſe. The ſame happened when the experiments were made on the droſera longifolia, but more rapidly.

Roth alſo found that the hairs bent themſelves when he touched them with the point of a needle, with a hog's briſtle, or when he placed a very ſmall piece of wood the weight of an ant upon the leaves.

Mr Lyall next gives us an account of his own experiments. He ſays, "that for five months, he almoſt, every day, had the ſpecies of droſeræ under his eye, either at home or in the country; and he confeſſes, that he never ſaw ſuch a rapid contraction of the leaves of the droſera rotundifolia, as had been noticed by Meſſrs Whately and Gardom: but in all his experiments the contraction was gradual, though it ſeldom failed to happen, if the plant was in good condition. In moſt of his experiments an hour was neceſſary for the complete bending of all the hairs; and it required ſome hours for the perfect ſhutting up of the leaves. Hence it is evident, that whoever has a wiſh to notice the motions of the droſeræ, muſt not ſet out with the expectation of ſeeing a rapid motion, ſimilar to what happens in the mimoſæ, follow the application of a ſtimulus; but, to obſerve the ultimate effects, muſt watch with an attentive eye, for at leaſt 20 minutes.

In accounting for the manner in which theſe motions are performed, various opinions have been held. Brouſſonet ſuſpects that the diſengagement of ſome fluids influences them. He ſays, that the inſect, by abſorbing the fluid which is on the points of the hairs, empties the veſſels of the leaf, which folds upon itſelf; and the quickneſs of the action is proportional to the number of hairs touched by the inſect.

Our author obſerves, that "this theory, at firſt ſight, does not appear even to be plauſible; for, how is it poſſible that an inſect can abſorb a thick tenacious fluid? No doubt, however, part of this fluid will be attached to the part of the inſect which touches it; but this ſeems quite unconnected with the contraction of the leaf. On the 30th of July, Mr Lyall brought from the country a number of plants of the droſera rotundifolia, and, on inſpecting them, he found many of the hairs of the leaves deprived of their viſcid fluid; but yet both they and the leaf remained quite expanded and in good condition. Next day, about four o'clock, he placed a ſmall bit of ſulphate of copper, in the diſk of one of theſe expanded leaves, and by ſix o'clock moſt of the hairs on one ſide of the leaf, even the outermoſt, had bent themſelves over the bit of copper; this ſeems to to prove the inaccuracy of Brouſſonet's theory. In other experiments, he placed ſmall bits of bread or wood, on three or four of the central hairs, without touching the other hairs, or the viſcid fluid on their ends; and in a few hours he found that all the hairs had contracted around the foreign body. In ſome plants, the ſulphate of copper was placed upon ſome of the ſmall hairs in the diſk of the leaf, without touching the leaf itſelf; yet the bending of the hairs and leaf was complete.

" We have here proof (he adds), 1ſt, That the leaves do not contract when deprived of their viſcid fluid, which ought to have been the caſe if Brouſſonet's theory had been true. 2dly, That the contraction takes place even when the viſcid fluid does not cover the little glands. 3dly, That the contraction follows, although the foreign body is not brought into contact with all the hairs.

The opinion of Sennebier, who appears to have aſcribed the motions of the droſeræ to the effect of preſſure is next examined. " Sennebier ſeems (it is obſerved) ſenſible, that the contractions of the leaves take place even when light bodies are placed on them, which circumſtance of itſelf would lead us to ſuſpect, that preſſure is not alone the cauſe.

" I know (it is added), that, if we preſs on the centre of a leaf with a pin, &c. we may cauſe its margin to approximate the pin; and this certainly would be owing to a mechanical cauſe. But, ſuppoſe we ſee the contraction take place, as I have done, when a body ſpecifically lighter than the leaf itſelf is placed in the centre, as a bit of rotten wood; ſhould we be ſtill inclined to aſcribe it to a mechanical cauſe? Admit that it is the caſe. Suppoſe, then, we place the ſame bit of wood on the margin of the leaf, what effect ought to follow? If it were owing to a mechanical cauſe, or the weight of the foreign body, as in the laſt-mentioned caſe, then we ſhould expect, that the part of the margin of the leaf, on which the bit of wood reſted, would be depreſſed; which undoubtedly is not the caſe: but, on the contrary, the margin riſes, and then contracts towards the foreign body, or towards the footſtalk of the leaf.

" That this motion does not depend on preſſure, may be ſtill better illuſtrated, by placing a fly, or ſome other body, on the apex of a leaf of the droſera longifolia. The hairs near the foreign body will contract around it, and then the apex of the leaf will riſe upwards, and turn inwards, until it touches the baſe. Or, if the offending body is ſmall, the leaf will become convoluted around it."

From the reſult of his experiments, the author thinks, that the motions of the leaves of the droſeræ cannot be explained on mechanical principles. He conceives, that theſe motions are performed, if not by muſcles, at leaſt by *ſomething* which is equivalent to muſcles in the animal body.

It appears that the leaves of the droſera rotundifolia and longifolia remain completely expanded during the hotteſt ſunſhine and drieſt weather; during the coldeſt and wetteſt weather; during the greateſt darkneſs, and, finally, during the brighteſt light of day. This, however, is to be taken in a limited ſenſe, i. e. only during the expanſion of the leaves, not during the cold of winter. " Here, then, neither heat, cold, dryneſs, dampneſs, darkneſs, nor light in general, at all affect the leaves; but, if a foreign body be applied to the leaf ſo as to ſtimulate, then it will ſhut up" in the manner we have already deſcribed.

EXPLANATION OF PLATES DXLI. DXLII. AND DXLIII.

[*Note, that ſome errors in the references to figures in the text may be corrected by this explanation, which is accurate.*]

Fig. 1. Part of a branch, ſhewing the manner in which the line of life, *c c*, enters into the flower-bud, *a*, and paſſes by the leaf, *b b*.

Fig. 2. A flower-bud, ſhowing the line of life, *c c*, running up to each flower, *a, a, a, a, a, a, a*, and the pith terminating at *b*.

Fig. 3. Section of the ſtem of a tree; *a*, the rind; *b*, the bark; *c*, the inner bark; *d*, the wood; *e*, the ſpiral nerves; *f*, the corona or line of life; *g*, the pith; *h, h*, the ſilver grain; *o, o, o*, the baſtard grain.

Fig. 4. Cylinders of the inner bark.

Fig. 5. Cylinders of the wood.

Fig. 6, 7, 8, 9. Commencement of the growth of leaves, exhibited in different ſtages. *a, a, a, a*, The mid-rib; *b, b, b*, the young veſſels appearing like cotton; *c, c*, the ſpiral nerves; *d*, the ſmaller veſſels croſſing each other. Fig. 9. alſo ſhews *e, e*, the fine veſſels growing up each ſide of the mid-rib; and *f*, the pabulum.

Fig. 10. Leaf-bud of the lime-tree.

Fig. 11. Leaf-bud of the horſe-cheſnut about January.

Fig. 12. A ſeed-veſſel of the claſs ſyngeneſia; *a*, the calyx; *b*, female florets; *c*, male and female florets.

Fig. 13. Section juſt above the ſeed-veſſel of the dianthus. *a*, the calyx proceeding from the bark; *b*, the corolla, from the inner bark; *c, c, c, c*, ten ſtamina from the wood; *d*, the ſeed-veſſel; *e*, the piſtil from the corona or circle of life.

Fig. 14. Repreſentation of the bean. *o, o*, the nouriſhing veſſels; L to *n*, the ſeminal leaves, or cotyledons; *l*, to *l*, the embryo.

Fig. 15. *o*, The nouriſhing veſſels; *l l*, the embryo in the ſeed of the lily, croſſing the empty part of the corculum.

Fig. 16. Shews *l, l*, the line of life; *o, o*, the nouriſhing veſſels.

Fig. 17. Repreſents the heart taken out of the ſeed of a cheſnut. *l*, the circular hook; *o, o*, the nouriſhing veſſels; *l, l*, the line of life, which was taken out where it croſſes the heart at *m*.

Fig. 18. The ſeed of the gooſeberry. *o*, the nouriſhing veſſels; *l*, the line of life; *m*, the corculum or heart.

Fig. 19. The ſting of the nettle, as viewed with the ſolar microſcope; *z*, the bag of poiſon; *x*, the ſpiral wire.

Fig. 20. The ſting after the poiſon has been thrown to the point; *x*, the ſpiral wire contracted.

Fig. 21. Indian graſs greatly magnified, ſhowing the manner in which it is formed.

Fig. 22. Awn of the graſs.

Fig. 23. and 24. The graſs twiſted.

Fig. 25. Leaf of the mimoſa ſenſitiva.

Fig. 26. A longitudinal ſection of the leaf-ſtalk of the mimoſa ſenſitiva, the middle part containing five caſes of ſpiral wire, and each extremity only three.

Fig. 27. The extremity of the uncut leaf-ſtalk, which is divided at *pp* in fig. 26.

Fig. 28. A horizontal ſection of the ſtem of the mimoſa.

Fig. 29. A caſe full of the ſpiral wire much magnified.

Fig. 30. Spiral wire ſtill more magnified.

Fig. 31. Leaf of the mimoſa pudica.

VEGETATIVE SOUL, among philoſophers, denotes that principle in plants, by virtue of which they vegetate, or receive nouriſhment and grow.

VEHICLE, in general, denotes any thing that carries or bears another along; but is more particularly uſed in pharmacy for any liquid ſerving to dilute ſome medicine, in order that it may be adminiſtered more commodiouſly to the patient.

VEII, in *Ancient Geography*, a city of Etruria, the long and powerful rival of Rome; diſtant about 100 ſtadia, or 12 miles, to the north-weſt; ſituated on a high and ſteep rock. Taken after a ſiege of 10 years by Camillus, ſix years before the taking of Rome by the Gauls: and thither the Romans, after the burning of their city, had thoughts of removing; but were diſſuaded from it by Camillus (Livy). It remained ſtanding after the Punic war; and a colony was there ſettled, and its territory aſſigned to the ſoldiers. But after that it declined ſo gradually, as not to leave a ſingle trace ſtanding. Famous for the ſlaughter of the 300 Fabii on the Cremera (Ovid). The ſpot on which it ſtood lies near Iſola, in St Peter's patrimony (Holſtenius).

VEIL, a piece of ſtuff, ſerving to cover or hide any thing.

In the Romiſh churches, in time of Lent, they have veils or curtains over the altar, crucifix, images of ſaints, &c.

A veil of crape is worn on the head by nuns, as a badge of their profeſſion: the novices wear white veils, but thoſe who have made the vows black ones. See the article NUN.

VEIN, in *Anatomy*, is a veſſel which carries the blood from the ſeveral parts of the body to the heart. See ANATOMY, N° 123.

VEIN, among miners, is a fiſſure in the horizontal ſtrata which contains ore, ſpar, cauk, clay, chert, croil, brownhen, pitcher-chert, cur, which the philoſophers call the *mother of metals*, and ſometimes *ſoil of all colours*. When it bears ore, it is called a *quick vein*; when no ore, a *dead vein*.

VELA, a remarkable cape on the coaſt of Terra Firma, in South America. W. Long. 71. 25. N. Lat. 12. 30.

VELARIUS, in antiquity, an officer in the court of the Roman emperors, being a kind of uſher, whoſe poſt was behind the curtain in the prince's apartment, as that of the chancellor's was at the entry of the balluſtrade; and that of the oſtiarii at the door. The velarii had a ſuperior of the ſame denomination, who commanded them.

VELEZ-DE-GOMARA, a town of Africa, in the kingdom of Fez, and in the province of Eriff. It is the ancient ACARTH. With a harbour and a handſome caſtle, where the governor reſides. It is ſeated between two high mountains, on the coaſt of the Mediterranean ſea. W. Long. 4. 0. N. Lat. 35. 10.

VELITES, in the Roman army, a kind of ancient ſoldiery, who were armed lightly with a javelin, a caſk, cuiraſs, and ſhield.

VELLEIUS PATERCULUS. See PATERCULUS.

VELLUM, is a kind of parchment, that is finer, evener, and more white than the common parchment. The word is formed from the French *velin*, or the Latin *vitulinus*, "belonging to a calf."

VELOCITY, in *Mechanics*, ſwiftneſs; that affection of motion whereby a moveable is diſpoſed to run over a certain ſpace in a certain time. It is alſo called *celerity*, and is always proportional to the ſpace moved. See QUANTITY, N° 11 and 14, &c.

VELVET, a rich kind of ſtuff, all ſilk, covered on the outſide with a cloſe, ſhort, fine, ſoft ſhag, the other ſide being a very ſtrong cloſe tiſſue.

The nap or ſhag, called alſo the *velveting*, of this ſtuff, is formed of part of the threads of the warp, which the workman puts on a long narrow-channelled ruler or needle, which he afterwards cuts, by drawing a ſharp ſteel tool along the channel of the needle to the ends of the warp. The principal and beſt manufactories of velvet are in France and Italy, particularly in Venice, Milan, Florence, Genoa, and Lucca: there are others in Holland, ſet up by the French refugees; whereof that at Haerlem is the moſt conſiderable: but they all come ſhort of the beauty of thoſe in France, and accordingly are ſold for 10 or 15 per cent. leſs. There are even ſome brought from China; but they are the worſt of all.

VENAL, or VENOUS, in *Anatomy*, ſomething that bears a relation to the veins. This word is alſo uſed for ſomething bought with money, or procured by bribes.

VENEERING, VANEERING, or *Fineering*, a kind of marquetry, or inlaying, whereby ſeveral thin ſlices or leaves of fine wood, of different kinds, are applied and faſtened on a ground of ſome common wood.

There are two kinds of inlaying: the one, which is the more ordinary, goes no farther than the making of compartiments of different woods; the other requires much more art, and repreſents flowers, birds, and the like figures. The firſt kind is what we properly call *veneering*; the latter we have already deſcribed under MARQUETRY.

The wood intended for veneering is firſt ſawed out into ſlices or leaves, about a line thick: in order to ſaw them, the blocks or planks are placed upright in a kind of vice or ſawing preſs: the deſcription of which may be ſeen under the article juſt referred to. Theſe ſlices are afterwards cut into ſlips, and faſhioned divers ways, according to the deſign propoſed; then the joints being carefully adjuſted, and the pieces brought down to their proper thickneſs, with ſeveral planes for the purpoſe, they are glued down on a ground or block of dry wood, with good ſtrong Engliſh glue. The pieces thus joined and glued, the work, if ſmall, is put in a preſs; if large, it is laid on the bench, covered with a board, and preſſed down with poles, or pieces of wood, one end whereof reaches to the ceiling of the room, and the other bears on the boards. When the glue is quite dry they take it out of the preſs and finiſh it; firſt with little planes, then with divers ſcrapers, ſome whereof reſemble raſps, which take off dents, &c. left by the planes. When ſufficiently ſcraped, the work is poliſhed with the ſkin of

VEGETABLE PHYSIOLOGY

Plate DXLI.

Fig. 1.

Fig. 2.

Fig. 3.

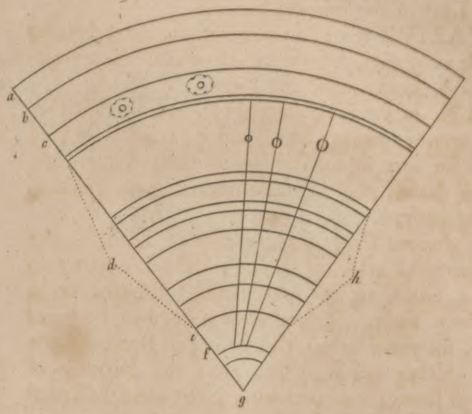

Fig. 4.

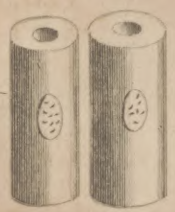

Fig. 5.

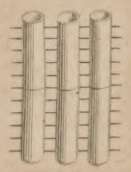

Fig. 6.

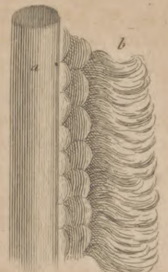

Fig. 7.

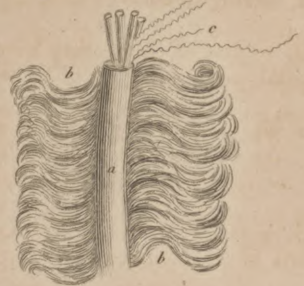

Fig. 8.

Fig. 9.

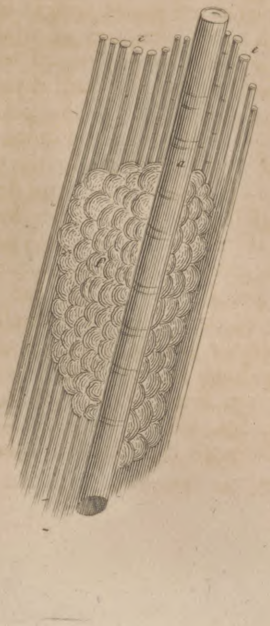

Fig. 10.

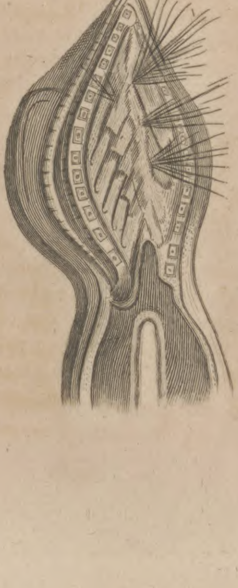

Fig. 11.

E. Mitchell sculp.


Fig. 12.


Fig. 13.


Fig. 14.

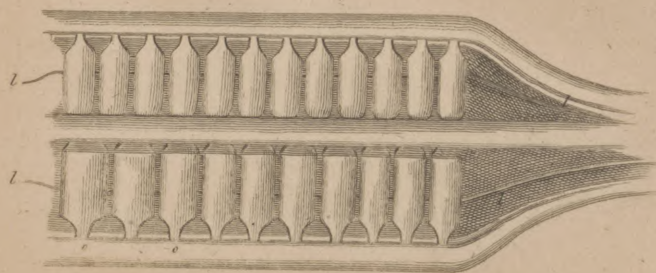
Fig. 16.

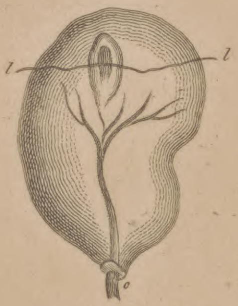
Fig. 15.


Fig. 17.


Fig. 18.

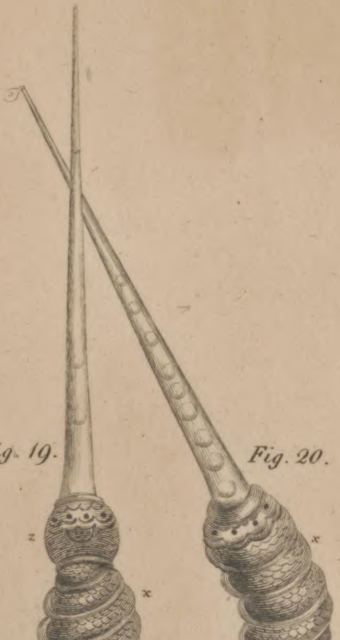
Fig. 19.
Fig. 20.


Fig. 21.

E. Mitchell sculpt.

VEGETABLE PHYSIOLOGY Plate DXLIII.

Fig. 22.

Fig. 23.

Fig. 24.

Fig. 25.

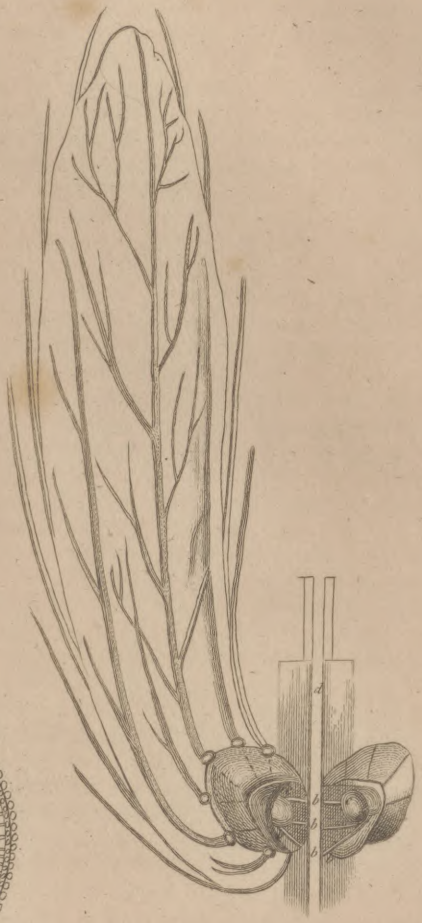

Fig. 26.

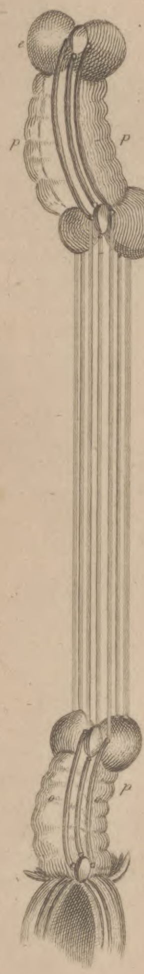

Fig. 27.

Fig. 28.

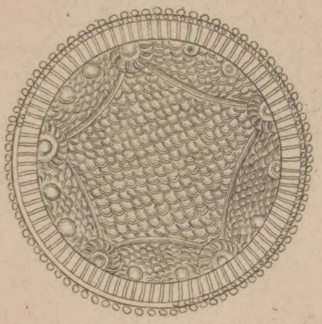

Fig. 29.

Fig. 30.

Fig. 31.

E. Mitchell sculpt.

a ſea-dog, wax, and a bruſh and poliſher of ſhave-graſs: which is the laſt operation.

VENEREAL, ſomething belonging to venery; as the *lues venerea*, &c. See MEDICINE *Index*.

VENERY, is commonly uſed for the act of copulation, or coition, between the two ſexes; it has alſo been employed by old writers as applicable to hunting or *the chace*, as *beaſts of venery*.

VENESECTION, or PHLEBOTOMY, in *Surgery*. See SURGERY *Index*.

VENETIAN BOLE, a fine red earth uſed in painting, and called in the colour ſhops *Venetian red*.—It is dug up in Carinthia, and ſent from Venice to all parts of the world; but the uſe of it is much ſuperſeded by a bright colcothar of vitriol.

1 Situation and boundaries.

VENICE, STATE OF, a celebrated republic, which for nearly ten centuries formed one of the moſt powerful of the maritime ſtates of Europe. Its dominions lay chiefly along the coaſts at the head of the Adriatic ſea, comprehending not only a conſiderable tract round the city of Venice, but ſeveral diſtricts both to the eaſt and weſt of that ſea, together with the iſlands of Corfu, Zante, Cephalonia, Cerigo, and ſome others of leſs note in the Archipelago. It was bounded to the north by the Alps, to the weſt by the duchy of Milan, and to the eaſt by Croatia, a province of Turkey in Europe.

2 Origin. An. 452.

The republic of Venice is ſaid to have taken its riſe from a ſmall Italian colony, who in the middle of the 5th century were driven by Attila king of the Huns from the cities of Aquileia, Verona, Mantua, &c. and took refuge in the group of ſmall iſlands where now ſtands the city of Venice. Here they eſtabliſhed themſelves, and formed a ſmall independent ſtate, adopting the conſular form of government which had ſo long prevailed at Rome. By the end of the 5th century they had become of conſequence, and were able to raiſe and maintain a fleet and a ſmall army. They engaged in a war with the Lombards, and diſtinguiſhed themſelves againſt the Iſtrian pirates, and the inhabitants of the neighbouring port of Trieſte. They alſo aſſiſted Juſtinian in his conteſt with the Goths, and received from him and his general Narſes, many marks of favour and diſtinction.

3 Eſtabliſhment of a doge or duke. An. 697.

About the year 697, the tribunitian power, which had prevailed in Venice from the end of the 5th century, was aboliſhed, and the ſtates elected a ſupreme magiſtrate, whom they called doge, or duke. He was to repreſent the honour and majeſty of the ſtate; to aſſemble and preſide at the great council, where he had a caſting vote in all diſputed points; to nominate to all offices, places, and preferments, and to enjoy the ſame authority in the church as in the ſtate. Excepting a ſhort intermiſſion of about five years, the power of the doges continued till the fall of the republic.

4 War with the emperor Charlemagne. An. 765.

Under the doges, the power and wealth of the republic continued to increaſe. In 765, the Heraclians and Gezulans, ſubjects of the republic, revolted, and threw themſelves on the protection of the emperor Charlemagne. That emperor ſettled them for the preſent at Malamoe, in the neighbourhood of the Venetian capital; but from this aſylum they were quickly driven by the forces of the republic. Incenſed at this affront committed againſt his authority, Charlemagne ordered his ſon Pepin to declare war againſt the Venetians; but as Aſtolphus king of the Lombards was then laying waſte the territories of the church, the troops of Pepin were, by the intreaties of the pope, diſpatched againſt that powerful monarch; and though, on the defeat of Aſtolphus they marched againſt the Venetians, it does not appear that the enterpriſe was productive of either honour or ſucceſs. The war with Pepin was renewed in 804, on occaſion of Obelerio, the doge of Venice, ſhewing an inclination to favour the Greek emperor Nicephorus againſt Pepin. Obelerio was related to the French monarch, having married his ſiſter; and as on this account the Venetians were jealous of the attachment of their doge, he was ſuperſeded, and Valentin nominated commander in his place. Pepin had collected a numerous and well appointed army, and had fitted out a fleet to act againſt the Venetians by ſea. With this formidable force he advanced directly to Venice, but here he was oppoſed with all the valour of independent citizens fighting for their liberties.

5 Intrepidity and ſucceſs of the Venetians. An. 804.

The Venetians, however, notwithſtanding the moſt obſtinate defence, the moſt vigorous ſallies, and their ſelling every inch of ground at an incredible expence of blood, were at length reduced to that part of the city ſouth of the Rialto (*ſee the next article*); this ſtream and their own bravery, being now their only defence. While Pepin was preparing to throw a bridge over the canal, they reſolved, as a laſt effort, to attack Pepin's fleet, and to vanquiſh or die in defence of their liberty. Embarking all the troops they could ſpare, they bore down with the advantage of the wind and tide, upon the enemy, and began the attack with ſuch fury, as obliged the French admiral to give way. The lightneſs of their ſhips, and the knowledge of the ſoundings, gave the Venetians every advantage they could wiſh: the enemy's fleet was run aground, and the greater part of their troops periſhed in attempting to eſcape; the ſhips were all to a few either taken or deſtroyed. During this action at ſea, Pepin reſolved to aſſault the city by land, not doubting but the garriſon was ſo weakened by the number of forces they had ſent on board the fleet, as to be able to make but a ſlight reſiſtance. Having for this purpoſe thrown a bridge over the Rialto, he was marching his troops acroſs it, when he found himſelf attacked on every ſide by the Venetians from their boats, and others who had poſted themſelves on the bridge. The battle was long, bloody, and doubtful, until the Venetians employed all their power to break down the bridge; which at laſt yielding to their obſtinate endeavours, a prodigious ſlaughter of the French enſued; they fought, however, like men in deſpair, ſeeing no hopes of ſafety but in victory; but all communication being cut off with the troops on ſhore, they were to a man either killed or drowned. The number of ſlain was ſo great, that the ſpace between the Rialto and Malamoe was covered with dead bodies, and has ever ſince gone by a name expreſſive of the prodigious ſlaughter. Pepin was ſo ſtruck with the intrepidity of the Venetians, that he raiſed the ſiege, abandoned the enterpriſe, and concluded a peace with the republic.

6 Venetian fleet defeated by the Saracens. An. 839.

In 839, the Venetians engaged in an offenſive and defenſive alliance againſt the Saracens, with the Greek emperor Michael, to whoſe aſſiſtance they ſent a fleet of 60 galleys. In an engagement which took place between the allied fleets and that of the Saracens, the former

mer were completely defeated, and almoſt all the Venetian galleys were either taken or deſtroyed. On the news of this defeat, the capital was thrown into the greateſt conſternation, juſtly dreading an attack from the victorious Saracens. This alarm, however, ſoon ſubſided, on finding that the barbarians had turned off on the ſide of Ancona. The city now became a prey to internal diſſenſion. Popular tumults were frequent, and in one of theſe the doge was murdered. By the prudent and vigorous adminiſtration of a ſucceeding doge, Orſo Participato, good order was re-eſtabliſhed, and at the commencement of the 10th century, the reputation of the republic for military proweſs was much advanced by a victory gained over the Huns, who had invaded Italy, and defeated Berengarius.

7
Increaſed power of the republic.
An. 1084.

Towards the cloſe of the 11th century, Venice began to make a conſiderable figure among the ſtates of Europe, having acquired the ſovereignty of Dalmatia and Croatia, with which in 1084 they were formally inveſted by the Conſtantinopolitan emperor.

8
Take an active part in the cruſades.
An. 1096.

About this time a cruſade, or holy war againſt the Saracens, was preached up by the emiſſaries of the pope, and the Venetian republic engaged in the undertaking with ſuch ardour, as to equip a fleet of 200 ſail, under the command of the doge Vitalis Michael. Before he ſailed for the coaſt of Aſia, however, the doge found it neceſſary to chaſtiſe the Piſans, whom he defeated in a terrible engagement. He then ſailed for Aſkalon, at that time beſieged by the Chriſtian forces, and it was chiefly by his valour that that city, as well as Caipha and Tiberias, fell into the hands of the Chriſtians. From theſe victories he was recalled to repel an invaſion of Dalmatia by the Normans, whom he alſo defeated, carrying off conſiderable booty. His ſucceſſor aſſiſted Baldwin in the conqueſt of Ptolemais, but was defeated and killed in attempting to quell a rebellion of the Croatians.

9
Diſpute with the Greek emperor,

Under the government of Domenico Micheli, who ſucceeded Ordelapho, the pope's nuncio arrived at Venice, and excited ſuch a ſpirit of enthuſiaſm among all ranks and degrees of men, that they ſtrove whoſe names ſhould be firſt enrolled for the holy war. The doge, having fitted out a fleet of 60 galleys, ſailed with it to Joppa, which place the Saracens were at that time beſieging. The garriſon was reduced to the laſt extremity when the Venetian fleet arrived, which ſurpriſed and defeated that of the enemy with great ſlaughter; ſoon after which the Saracens raiſed the ſiege with precipitation. Tyre was next beſieged, and ſoon was obliged to capitulate; on which occaſion, as well as on the taking of Aſcalon, the Venetians ſhared two-thirds of the ſpoils. While the doge was abſent on thoſe important affairs, the emperor of Conſtantinople, jealous of the growing power of the Venetians, reſolved to take advantage of their apparent incapacity to reſiſt an attack at home. The Venetians, however, had timely notice of his approach, and inſtantly recalled the doge, who on his return laid waſte and deſtroyed the country round Chios, ſeized on the iſlands of Samos, Leſbos, and Andros, then belonging to the emperor, and reduced ſeveral places in Dalmatia which had revolted.

10
and with Barbaroſſa.
An. 1173.

In 1173, the republic ventured to oppoſe Frederick Barbaroſſa in his attack on the pope. Frederick, after a haughty reply to an embaſſy ſent him by the Venetians, diſpatched againſt them his ſon Otho, who ſoon arrived before the city with 75 galleys. The doge Sebaſtiano Ziani ſailed out with the few veſſels he had got equipped, to give the enemy battle. The fleets met off the coaſt of Iſtria, and a terrible engagement enſued, in which the imperial fleet was totally defeated, Otho himſelf taken priſoner, and 48 of his ſhips deſtroyed. On the doge's return, the pope went out to meet him, and preſented him with a ring, ſaying, "Take this, Ziani, and give it to the ſea, as a teſtimony of your dominion over it. Let your ſucceſſors annually perform the ſame ceremony, that poſterity may know that your valour has purchaſed this prerogative, and ſubjected this element to you, even as a huſband ſubjecteth his wife." Otho was treated with the reſpect due to his rank, and ſoon conceived a great friendſhip for Ziani. At laſt, being permitted to viſit the imperial court, on his parole, he not only prevailed on his father to make peace with the Venetians, but even to viſit their city, ſo famed for its commerce and naval power. He was received with all poſſible reſpect, and on his departure attended to Ancona by the doge, the ſenate, and the whole body of the nobility. During this journey he was reconciled to the pope; and both agreed to pay the higheſt honours to the doge and republic.

11
They gain poſſeſſion of Conſtantinople.
An. 1204.

In the beginning of the 13th century, the Venetians in conjunction with the French, beſieged and took Conſtantinople, as has been related under the article CONSTANTINOPOLITAN HISTORY, N° 144—146, which they held till the year 1261.

12
War with the Genoeſe.

An. 1348.

In the mean time the Genoeſe, by their ſucceſsful application to commerce, having raiſed themſelves in ſuch a manner as to be capable of rivalling the Venetians, a long ſeries of wars took place between the republics; in which the Venetians generally had the advantage, though ſometimes they met with terrible overthrows. Theſe expenſive and bloody quarrels undoubtedly contributed to weaken the republic notwithſtanding its ſucceſſes. In the year 1348, however, the Genoeſe were obliged to implore the protection of Viſconti duke of Milan, in order to ſupport them againſt their implacable enemies the Venetians. Soon after this, in the year 1352, the latter were utterly defeated with ſuch loſs, that it was thought the city itſelf muſt have fallen into the hands of the Genoeſe, had they known how to improve their victory. This was in a ſhort time followed by a peace; but from this time the power of the republic began to decline. Continual war with the ſtates of Italy, with the Hungarians, and their own rebellious ſubjects, kept the Venetians employed, ſo that they had no leiſure to oppoſe the Turks, whoſe rapid advances might have alarmed all Europe. After the deſtruction of the eaſtern empire, however, in 1453 the Turks began more immediately to interfere with the republic. Whatever valour might be ſhewn by the Venetians, or whatever ſucceſſes they might boaſt of, it is certain the Turks ultimately prevailed; ſo that for ſome time it ſeemed ſcarcely poſſible to reſiſt them. What alſo contributed greatly to the decline of the republic, was the diſcovery of a paſſage to the Eaſt Indies by the Cape of Good Hope in 1497. Till then the greateſt part of the Eaſt India goods imported into Europe paſſed through the hands of the Venetians; but as ſoon as the Cape was diſcovered, the conveyance by the way of Alexandria almoſt entirely ceaſed. Still, however, the Venetian

power

13
Oppoſed by the league of Cambray.
An. 1508.

power was ſtrong; and in the beginning of the 16th century they maintained a war againſt almoſt the whole force of France, Germany, and Italy, aſſociated againſt them in what has been called the *League of Cambray*. Soon after, however, we find them entering into an alliance with the king of France againſt the emperor.

14
New wars with the Turks.
An. 1645.

After this, nothing of importance occurs in the hiſtory of the Venetian republic till the year 1645, when the republic was involved in a new and ſanguinary conflict with the Turks, in defence of the important iſland of Candia. The tranſactions to which this war gave riſe, and the ſpirit and bravery diſplayed by the Venetians, in defending their colonial poſſeſſions, are amply detailed under the article Candia.

15
The Venetians conquer the Morea;
An. 1687.

At the end of the 17th century, the Venetians obtained an important acquiſition of territory by the conqueſt of the Morea, which at the peace of Carlowitz in 1699, was formally ceded by Turkey to the ſtate of Venice*.

16
which is ſoon after reſtored to Turkey.
An. 1715.

During the war of the Succeſſion, the ſtates of Venice obſerved a ſtrict neutrality. They conſidered that diſpute as unconnected with their intereſts; taking care, however, to keep on foot an army on their frontiers in Italy, of ſufficient force to make them reſpected by the belligerent powers. But ſoon after the peace of Utrecht, the Venetians were again attacked by their old enemies the Turks, who beholding the great European powers exhauſted by their late efforts, and unable to aſſiſt the republic, thought this the favourable moment for recovering the Morea, which had been ſo lately raviſhed from them. The Turks obtained their object, and at the peace of Paſſarowitz in 1715, which terminated this unſucceſsful war, the Venetian ſtates yielded up the Morea; the grand ſeignior on his part reſtoring to them the ſmall iſlands of Cerigo and Cerigetto, with ſome places which his troops had taken during the courſe of the war in Dalmatia.

17
The ſtate of Venice becomes a province of Auſtria.

An. 1797.

From the peace of Paſſarowitz to the concluſion of the 18th century, the affairs of Venice ceaſed to form an intereſting part of the hiſtory of Europe. Ever ſince the league of Cambray, the republic, weakened by its continual ſtruggles with Turkey, had declined in power and in conſequence, and was incapable of oppoſing a barrier to the encroachments of its more powerful neighbours. During the firſt war which the French republic maintained againſt the emperor in Italy, the ſtates of Venice afforded a tempting object to each of the contending parties; and in May 1797, the capital was occupied by a body of French troops, who, under pretence of quelling a tumult that had ariſen in the city, took poſſeſſion of the forts, and ſubverted the exiſting authorities. By the treaty of Campo Formio, concluded between the emperor and the French republic in October of the ſame year, the French conſented that the emperor ſhould take poſſeſſion of the Venetian territory, with the iſlands in the Archipelago, which had been ſubjected to the Venetian republic; and by the ſubſequent treaty of Luneville in 1801, this acceſſion of territory to the houſe of Auſtria was confirmed, ſo that the Venetian republic muſt now be conſidered as an Auſtrian province.

18
Conſtitution, government, &c. of the late republic.

It is not neceſſary for us to be very minute in our account of the late conſtitution and government of Venice. The government was ſtrictly ariſtocratical, being veſted in the great council or ſenate, in which each of the nobility had a ſeat. The nobility were extremely numerous, being computed at not fewer than 2000, whereas the whole population of the ſtate did not exceed 2,500,000. Beſides the great council, or *il conſiglio grande*, there were four others; one compoſed of the doge and ſix counſellors, called *la ſignoria;* another called *il conſiglio du pregodi*, conſiſting of about 250 of the nobility; a third united to *la ſignoria*, conſiſting of 28 aſſeſſors, or great ſages, which gave audience to ambaſſadors; and a fourth, compoſed of 10 counſellors, who took cognizance of all criminal matters, and before whom even the doge himſelf muſt appear, if accuſed. The ſecret buſineſs of the ſtate was often carried on by ſpies and informers; and there were in the ducal palace ſeveral ſtatues of lions with open mouths, which formed ſo many receptacles for ſecret and anonymous information.

The office and privileges of the doge of Venice have been already mentioned under the article Doge. Of late this office was little more than nominal; and the doge was a mere ſtate puppet, without authority and without power. His eſtabliſhment, however, was ſplendid, and his revenue not contemptible. The mode of electing the doge deſerves notice, as it was well calculated to prevent bribery, or the exertion of party influence. He was elected by a plurality of voices, and held his dignity for life. In his election they made uſe of gold and ſilver balls, which were put into a veſſel, and ſerved for balloting. Thoſe who drew nine golden balls, firſt elected 40 counſellors, who drew 12 others, and elected 25 in addition. Of this number nine perſons, who had drawn golden balls, choſe 40 more; 11 of thoſe, appointed in the ſame way, choſe 41 counſellors, who finally proceeded to the election, till 25 votes or more fell upon the ſame perſon, who was then declared doge. After this election they placed the ducal cap upon his head, upon which he took poſſeſſion of the doge's palace. He never uncovered his head to any perſon, becauſe he did not wear the cap in his own name, but in that of the republic.

The military ſtrength of the Venetians conſiſted of nearly 30,000 land forces, under the command of a capitano, who was always a foreigner of diſtinction; beſides a conſiderable fleet, which they boaſted could, in time of war, be increaſed to 60 men of war, and above 100 galleys. The ordinary revenues of the ſtate have been computed at rather more than 1,000,000l. ſterling, a conſiderable part of which aroſe from the cuſtoms, and the duty on ſalt made at Corfu and Chioſa.

Venice, the city which was the ſeat of government of the Venetian republic, is built on 72 ſmall iſlands at the head of the Adriatic or gulf of Venice, about five miles from the main land. That part of the gulf which lies between the city and the continent forms a kind of *laguna* or lake, which, at low water, is very ſhallow, and on the oppoſite ſide of the iſlands there are numerous ſhallows, the channels between which are marked by ſtakes, to direct ſhips in entering the port. The lagunes that lie between the iſlands form ſo many canals that interſect the city in all directions, and over theſe the ſtreets communicate by not fewer than 500 bridges. The principal or *great* canal is broad, and has a ſerpentine courſe through the middle of the city, but the others are narrow and crooked. The ſtreets are alſo narrow and winding, but clean and neat. The houſes are built on piles, and have each a door opening to the

* See *Mod. Univ. Hiſt.* vol. xxvii.

adjacent canal, and another to the ſtreet. As the narrowneſs of the ſtreets but ill adapts them for walking in, the only places of reſort on land are the *Rialto*, a noble bridge acroſs the great canal, bordered with booths and ſhops, and the great ſquare of St Mark, or *Piazza di St Marco*, an irregular quadrangle, formed of ſeveral buildings, ſome of which are magnificent. Of theſe, the *ducal palace*, where the buſineſs of the ſtate uſed to be tranſacted; the patriarchal church of St Mark; the ſteeple of St Mark, at a little diſtance from the church; the church of St Geminiano; and the *new* and *old Procuraries*, are moſt deſerving the notice of travellers. The canals form the great medium of communication, as well as the principal ſcene of relaxation and amuſement to the inhabitants. Here ply numerous gondolas, (ſee GONDOLA, and *Macgill's Travels*, vol. i.) which are rowed with admirable ſpeed and dexterity by the gondoliers; and here are occaſionally held races, or rather rowing matches. As the canals are, of neceſſity, the receptacles of all the filth of the city, they become, in hot weather, very offenſive; while, in winter, from their free communication with the gulf, they are frequently agitated by the Adriatic ſtorms. The whole city is about ſix miles in circumference, and the inhabitants are eſtimated at 160,000.

The inhabitants of Venice carried on a flouriſhing trade in ſilk manufactures, gold lace, mirrors and other articles of glaſs, beſides military ſtores and implements of war. At ſome diſtance from the city there is a large and commodious lazaretto, where ſhips coming from the Levant unload their goods, and perform quarantine from 20 to 40 days.

This celebrated city, once the ſeat of power, opulence and the fine arts, whoſe carnival revelries have been the ſubject of ſo many animated deſcriptions, has undergone a melancholy change. Her ſtreets and canals no longer reſound with the ſtrains of the muſician and the ſerenades of watchful lovers, and her gay gondolas, which were formerly occupied by faſhionable groups and parties of pleaſure, are now become the vehicles of trade, or ſerve for the accommodation of the ſoldier and the mechanic. The trade of the city, which had long declined, has, ſince the ceſſion of the Venetian territory to Auſtria, been almoſt entirely transferred to Trieſte. Venice is 72 miles E. by N. of Mantua; 115 N. E. of Florence; 140 E. of Milan; 212 N. of Rome, and 300 N. by W. of Naples. E. Long. 12° 33′. N. Lat. 45° 26′.

VENIRE FACIAS, in *Law*, is a judicial writ lying where two parties plead and come to iſſue, directed to the ſheriff, to cauſe 12 men of the ſame neighbourhood to meet and try the ſame, and to ſay the truth upon the iſſue taken.

VENTER, ſignifies the belly; but it is alſo uſed for the children by a woman of one marriage: there is in law a firſt and ſecond venter, &c. where a man hath children by ſeveral wives; and how they ſhall take in deſcents of lands.

VENTILATOR, a machine by which the noxious air of any cloſe place, as an hoſpital, gaol, ſhip, chamber, &c. may be diſcharged and changed for freſh.

The noxious qualities of bad air have been long known; and no one has taken greater pains to ſet the miſchiefs ariſing from foul air in a juſt light than Dr Hales; who has alſo propoſed an eaſy and effectual remedy by the uſe of his ventilators; his account of which was read to the Royal Society in May 1741. In the November following M. Triewald, military architect to the king of Sweden, informed Dr Mortimer ſecretary to the Royal Society, that he had in the preceding ſpring invented a machine for the uſe of his majeſty's men of war, in order to draw out the bad air from under their decks, the leaſt of which exhauſted 36,172 cubic feet in an hour, or at the rate of 21,732 tons in 24 hours. In 1742 he ſent one of them, formed for a 60 gun ſhip to France; which was approved of by the Royal Academy of Sciences at Paris; and the king of France ordered all the men of war to be furniſhed with the like ventilators.

Plate DXLIV. Fig. 1.
Fig. 2.
Fig. 3.

The ventilators invented by Dr Hales conſiſt of a ſquare box ABCD (fig. 1.) of any ſize; in the middle of one ſide of this box a broad partition or midriff is fixed by hinges X, and it moves up and down from A to C, by means of an iron rod ZR, fixed at a proper diſtance from the other end of the midriff, and paſſing through a ſmall hole in the cover of the box up to R. Two boxes of this kind may be employed at once, and the two iron rods may be fixed to a lever FG (fig. 2.) moving on a fixed centre O; ſo that by the alternate raiſing and preſſing down of the lever FG, the midriffs are alſo alternately raiſed and depreſſed, whereby theſe double bellows are at the ſame time both drawing in air, and pouring it out, through apertures with valves made on the ſame ſide with, and placed both above and below the hinges of the midriffs. In order to render the midriffs light, they are made of four bars lengthwiſe, and as many acroſs them breadthwiſe, the vacant ſpaces being filled up with thin pannels of fir-board; and that they may move to and fro with the greater eaſe, and without touching the ſides of the boxes, there is an iron regulator fixed upright to the middle of the end of the box AC (fig. 1.) from N to L, with a notch cut into the middle of the end of the midriff at Z; ſo that the midriffs, in riſing and falling, ſuffer no other friction than what is made between the regulator and the notch. Moreover, as the midriff ZX moves with its edges only one-twentieth of an inch from the ſides of the box ABCDFE, very little air will eſcape by the edges; and, therefore, there will be no need of leathern ſides as in the common bellows. The end of the box at AC is made a little circular, that it may be better adapted between A and C to the riſing and falling midriff; and at the other end X of the midriff a ſlip of leather may be nailed over the joints if needful. The eight large valves through which the air is to paſs, are placed at the hinge-end of the boxes BK (fig. 2.) as at 1, 2, 3, &c. The valve 1 opens inward to admit the air to enter, when the midriff is depreſſed at the other end by means of the lever FG. And at the ſame time the valve 3 in the lower ventilator is ſhut by the compreſſed air which paſſes out at the valve 4. But when that midriff is raiſed, the valve 1 ſhuts, and the air paſſes out at the valve 2. And it is the ſame with the valves 5, 6, &c. of the other box; ſo that the midriffs are alternately riſing and falling. and two of the ventilators drawing in air, and two blowing it out; the air entering at the valves 1, 3, 6, 8, and paſſing out at the valves 2, 4. 5, 7. Before theſe laſt valves there is fixed to the ventilators a box QQNM (fig. 3.) as a common receptacle for all the air which comes out of theſe valves; which

which air paſſes off by the trunk P, through the wall of a building. See Deſcription of Ventilators by Stephen Hales, D. D. Lond. 1743, 8vo.; and for the method of freeing mines, ſhips, priſons, &c. from noxious air by means of fire-pipes, ſee PNEUMATICS, N° 371.

VENTRI Inſpiciendo, is a writ to ſearch a woman that ſaith ſhe is with child, and thereby withholdeth lands from the next heir: the trial whereof is by a jury of women.

VENTRICLE, properly denotes any little cavity; but is more particularly uſed by phyſicians and anatomiſts for the ſtomach and certain cavities of the heart and brain.

VENTRILOQUISM, an art by which certain perſons can ſo modify their voice, as to make it appear to the audience to proceed from any diſtance, and in any direction. See PHYSIOLOGY *Index*.

VENUS, in Pagan worſhip, the goddeſs of love and beauty. Cicero mentions two other deities of this name. Venus, ſtyled *Urania* and *Celeſtis*; and the *Venus Pandemos* or *Popularis*, the wife of Vulcan, and the goddeſs of wanton and effeminate love. To the firſt the Pagans aſcribed no attributes but ſuch as were agreeable to the ſtricteſt chaſtity and virtue; and of this deity they admitted no corporeal reſemblance, ſhe being only repreſented by the form of a globe, ending conically. Her ſacrifices were termed *nephalia*, on account of their ſobriety. To her honey and wine were offered, and no animal except the heifer; and on her altars the wood of figs, vines, or mulberries, was not ſuffered to be burnt. The Romans dedicated a temple to this goddeſs, to whom they gave the name of *Verticordia*; becauſe ſhe turned the hearts of lewd women, and inſpired them with modeſty and virtue.

But the moſt famous of theſe goddeſſes is the wife of Vulcan; who is repreſented as ſpringing from the froth raiſed by the genitals of Saturn, when cut off by Jupiter and thrown into the ſea. As ſoon as ſhe was formed, ſhe was laid in a beautiful ſhell embelliſhed with pearl, and wafted by gentle zephyrs to the iſle of Cytherea, whence ſhe ſailed to Cyprus. At her landing, flowers roſe beneath her feet; ſhe was received by the Hours, who braided her hair with golden fillets; and then wafted her to heaven, where her charms appeared ſo attractive, that moſt of the gods deſired her in marriage; but Vulcan, by the advice of Jupiter, gained poſſeſſion by putting poppies into her nectar. As Venus was the goddeſs of love and pleaſure, the poets have been laviſh in the deſcription of her beauties; and the painters and ſtatuaries have endeavoured to give her the moſt lovely form. Sometimes ſhe is repreſented clothed in purple, glittering with gems, her head crowned with roſes, and drawn in an ivory car by ſwans, doves, or ſparrows; at others ſhe ſtands attended by the Graces; but in all poſitions, her ſon Cupid is her inſeparable companion. She was honoured as the mother of Hymeneus, Cupid, Æneas, and the Graces, and was paſſionately fond of Adonis and Anchiſes.

This goddeſs was principally worſhipped at Paphos and Cyprus; and the ſacrifices offered to her were white goats and ſwine, with libations of wine, milk, and honey. Her victims were crowned with flowers, or wreaths of myrtle.

VENUS, one of the planets. See ASTRONOMY *Index*.

VENUS's Fly-trap. See *DIONÆA Muſcipula*, BOTANY *Index*.

VENUS, a genus of ſhell-fiſh. See CONCHOLOGY *Index*.

VEPRECULÆ, diminutive from *vepres*, "a briar or bramble"; the name of the 31ſt order in Linnæus's Fragments of a Natural Method. See BOTANY *Index*.

VERA-CRUZ, a ſea-port town of North America, New Spain, with a very ſecure and commodious harbour, defended by a fort. Here the flotilla annually arrives from Spain to receive the produce of the gold and ſilver mines of Mexico; and at the ſame time a fair is held here for all manner of rich merchandiſe brought from China and the Eaſt Indies by way of the South ſea, and for the merchandiſe of Europe by the way of the Atlantic ocean. This town is not two miles in circumference; and about it there is a wall of no great ſtrength on the land-ſide. The air is unwholeſome; and there are very few Spaniards here unleſs when the flotilla arrives, and then it is crowded with people from all parts of Spaniſh America. It is 200 miles ſouth-eaſt of Mexico. W. Long. 37. 25. N. Lat. 19. 12.

VERAGUA, a province of New Spain, bounded on the eaſt by that of Coſta Rica, on the weſt by Panama, on the north by Darien and the gulf of Mexico, and on the ſouth by the South ſea. It is about 125 miles in length from eaſt to weſt, and 60 in breadth from north to ſouth. It is a mountainous barren country; but has plenty of gold and ſilver. Conception is the capital town.

VERATRUM, a genus of plants belonging to the claſs polygamia, and in the natural ſyſtem arranged under the 10th order, *Coronariæ*. See BOTANY and MATERIA MEDICA *Index*.

VERB, in *Grammar*. See GRAMMAR, chap. iv.

VERBASCUM, a genus of plants of the claſs pentandria, and in the natural ſyſtem arranged under the 28th order, *Luridæ*. See BOTANY *Index*.

VERBENA, a genus of plants of the claſs of diandria, and in the natural ſyſtem arranged under the 40th order, *Perſonatæ*. See BOTANY *Index*.

VERD, CAPE, a promontory on the weſt coaſt of Africa, 40 miles north-weſt of the mouth of the river Gambia. W. Long. 17. 38. N. Lat. 14. 45.

The iſlands of Cape de Verd are ſeated in the Atlantic ocean, about 400 miles weſt of the Cape. They are between the 13th and 19th degree of latitude; and the principal are 10 in number, lying in a ſemicircle. Their names are, *St Antony*, *St Vincent*, *St Lucia*, *St Nicholas*, the *iſle of Sal*, *Bona Viſta*, *Mayo*, *St Jago*, *Fuego*, and *Brava*.

VERDICT (*Vere dictum*), is the anſwer of the jury given to the court concerning the matter of fact, in any caſe civil or criminal, committed by the court to their trial and examination. See LAW, N° clxxxvi. 51. and TRIAL.

VERDIGRISE, the acetate of copper, much uſed by painters as a green colour. See COPPER, CHEMISTRY *Index*.

VERDITER, or VERDATER, a preparation of copper, ſometimes uſed by painters, &c. for a blue; but

but more uſually mixed with a yellow for a green colour. See COPPER, CHEMISTRY *Index*, and *COLOUR-Making*, N° 28.

VERGE (*Virgata*), in *Law*, ſignifies the compaſs of the king's court, which bounds the juriſdiction of the lord ſteward of the houſehold; and which is thought to have been 12 miles round.

The term *verge* is alſo uſed for a ſtick or rod, whereby one is admitted tenant to a copyhold eſtate, by holding it in his hand, and ſwearing fealty to the lord of the manor.

VERGERS, certain officers of the courts of king's bench and common pleas, whoſe buſineſs it is to carry white wands before the judges. There are alſo vergers of cathedrals, who carry a rod tipped with ſilver before the biſhop, dean, &c.

VERGIL, POLYDORE. See VIRGIL.

VERJUICE, a liquor obtained from grapes or apples, unfit for wine or cyder; and chiefly uſed in ſauces, ragouts, &c.

VERMES, the ſixth claſs of animals in the Linnæan ſyſtem, comprehending five orders. See NATURAL HISTORY, and CONCHOLOGY and HELMINTHOLOGY *Index*.

VERMICELLI, or VERMICHELLY, a compoſition of flour, cheeſe, yolks of eggs, ſugar, and ſaffron, reduced to a paſte, and formed into long ſlender pieces like worms, by forcing it with a piſton through a number of little holes. It was firſt brought from Italy; and is chiefly uſed in ſoups and pottages.

VERMICULAR, an epithet given to any thing that bears a relation or reſemblance to worms.

VERMIFORMIS, in *Anatomy*, a term applied to various parts in the human body, bearing ſome reſemblance to worms.

VERMILION, a bright and beautiful red colour, compoſed of quickſilver and ſulphur, in great eſteem among the ancients under the name of *minium*. See CHEMISTRY, N° 1701, and 1713; but what goes by the name of minium amongſt us, is a preparation of lead, known alſo by the name of *red-lead*. See CHEMISTRY, N° 1832.

VERMIN is a general term, denoting thoſe animals which are either directly or indirectly injurious to mankind, the inferior animals, or the fruits of the earth; as fleas, caterpillars, flies, worms, &c.

VERMIN, *Deſtruction of*. As we propoſe in this article to point out the means of deſtroying ſome of thoſe animals that are hurtful or troubleſome to man, we ſhall employ the term vermin, in a more extended ſenſe, including alſo under it, mice, rats, moles, &c. We ſhall endeavour to collect the moſt uſeful obſervations that have been made on the means of diminiſhing or extirpating ſuch animals as are obviouſly injurious. We cannot avoid here remarking, that although the ſeemingly exceſſive increaſe of one ſpecies of animals is hurtful or inconvenient to another, or to man himſelf, and their exiſtence is attended with great loſs and damage, by their infeſting and deſtroying grains and other fruits of the earth deſtined for the food of man or thoſe animals that are ſubſervient to him; we are not of opinion that this exceſs ought to be conſidered merely as a uſeleſs excreſcence in the great ſcale of being; nor are we of opinion that their numbers ought not to be reduced, becauſe we are too ſhort-ſighted to comprehend the wiſe purpoſes for which they are called into life. We have heard ſuch a doctrine held up, although we are inclined to ſuſpect that it is founded on a love of ſingularity or indolence, rather than proceeding from pure motives of benevolence. But we muſt abſtain from ſuch diſcuſſions, and occupy the limits allotted to the proper ſubject of conſideration.

Rats and Mice.—Various methods have been propoſed for the deſtruction of theſe vermin. The following preparation has been recommended as very effectual. Take of the ſeeds of ſtaveſacre (*delphinium ſtaphiſagria*), or of louſewort (*pedicularis paluſtris*), powdered, more or leſs as the occaſion requires, one part; of oat meal, three parts: mix them well, and make them up into a paſte with honey. Lay pieces of this paſte in the holes, and on the places where mice and rats frequent; and it will effectually kill or rid the places of thoſe kind of vermin by their eating of it.

Some time ago the ſociety for encouraging arts propoſed a premium of 50l. for a preparation capable of alluring or faſcinating rats ſo that they might be taken alive. In conſequence of this, a great number of new traps, &c. were invented, and the following methods of alluring the rats to a certain place were publiſhed. One of the methods which is moſt eaſily and efficaciouſly practiſed, is the trailing of ſome pieces of their moſt favourite food, which ſhould be of the kind which has the ſtrongeſt ſcent, ſuch as toaſted cheeſe or boiled red herrings, from the holes or entrances of the cloſet to their receſſes in every part of the houſe or contiguous building. At the extremities and at different parts of the courſe of this trailed track, ſmall quantities of meal, or any other kind of their food, ſhould be laid to bring the greater number into the tracks, and to encourage them to purſue it to the place where they are intended to be taken; at that place, when time admits of it, a more plentiful repaſt is laid for them, and the trailing repeated for two or three nights.

Beſides this trailing and way-baiting, ſome of the moſt expert of the rat-catchers have a ſhorter, and perhaps more effectual method of bringing them together; which is the calling them, by making ſuch a whiſtling noiſe as reſembles their own call; and by this means, with the aſſiſtance of the way-baits, they call them out of their holes, and lead them to the repaſt previouſly prepared for them at the places deſigned for taking them. But this is much more difficult to be practiſed than the art of trailing; for the learning of the exact notes or cries of any kind of beaſts or birds, ſo as to deceive them, is a peculiar talent which is attained only by few.

In practiſing either of thoſe methods of trailing or calling, great caution muſt be uſed by the operator to ſuppreſs and prevent the ſcent of his feet and body from being perceived; which is done by overpowering that ſcent, by other ſcents of a ſtronger nature. In order to do this, the feet are to be covered with cloths rubbed over with aſafœtida, or other ſtrong ſmelling ſubſtances; and even oil of rhodium is ſometimes uſed for this purpoſe, but ſparingly, on account of its high price, though it has a very alluring as well as diſguſting effect. If this caution of avoiding the ſcent of the operators feet, near the track, and in the place where the rats are propoſed to be collected, be not properly obſerved, it will very much obſtruct the ſucceſs of the attempt

tempt to take them ; for they are very ſhy of coming where the ſcent of human feet lies very freſh, as it intimates to their ſagacious inſtinct the preſence of human creatures, whom they naturally dread. To the abovementioned means of alluring by trailing, way-baiting and calling, is added another of very material efficacy, which is the uſe of oil of rhodium, which like the *marum ſyriacum* and *valerian* in the caſe of cats, has a very extraordinary faſcinating power on theſe animals. This oil, as it is extremely dear, is therefore ſparingly uſed. It is exalted in a ſmall quantity in the place, and at the entrance of it, where the rats are intended to be taken, particularly at the time when they are to be laſt brought together, in order to their deſtruction ; and it is uſed alſo by ſmearing it on the ſurface of ſome of the implements uſed in taking by the method below deſcribed ; and the effect it has in taking off their caution and dread, by the delight they appear to have in it, is very extraordinary.

It is uſual, likewiſe, for the operator to diſguiſe his figure as well as ſcent, which is done by putting a ſort of gown or cloak, of one colour, that hides the natural form, and makes him appear like a poſt, or ſome ſuch inanimate thing, which habit muſt likewiſe be ſcented as above, to overpower the ſmell of his perſon ; and beſides this, he is to avoid all motion till he has ſecured his point of having all the rats in his power.

When the rats are thus enticed and collected, where time is afforded, and the whole in any houſe and outbuildings are to be cleared away, they are ſuffered to regale on what they moſt like, which is ready prepared for them, and then to go away quietly for two or three nights ; by which means thoſe that are not allured the firſt night, are brought afterwards, either by their fellows, or the effects of the trailing, &c. and will not fail to come duly again, if they are not diſturbed or moleſted. But many of the rat-catchers make ſhorter work, and content themſelves with what can be brought together in one night ; but this is never effectual, unleſs where the building is ſmall and entire, and the rats but few in number.

The means of taking them when brought together are various. Some entice them into a very large bag, the mouth of which is ſufficiently capacious to cover nearly the whole floor of the place where they are collected ; which is done by ſmearing ſome veſſel, placed in the middle of the bag, with oil of rhodium, and laying in the bag baits of food. This bag, which before lay flat on the ground with the mouth ſpread open, is to be ſuddenly cloſed when the rats are all in. Others drive or frighten them, by ſlight noiſes or motions into a bag of a long form, the mouth of which, after all the rats are come in, is drawn up to the opening of the place by which they entered, all other ways of retreat being ſecured. Others, again, intoxicate or poiſon them, by mixing with the repaſt prepared for them, the *coculus indicus*, or the *nux vomica.* They direct four ounces of *coculus indicus*, with 12 ounces of oatmeal, and two ounces of treacle or honey, made into a moiſt paſte with ſtrong beer ; but if the *nux vomica* be uſed, a much leſs proportion will ſerve than is here given of the *coculus*. Any ſimilar compoſition of theſe drugs, with that kind of food the rats are moſt fond of, and which has a ſtrong flavour to hide that of the drugs, will equally anſwer the end. If indeed *coculus indicus* be well powdered, and infuſed in ſtrong beer for ſome time, at leaſt half the quantity here directed will ſerve as well as the quantity before mentioned. When the rats appear to be thoroughly intoxicated with the coculus, or ſick with the nux vomica, they may be taken with the hand and put into a bag or cage, the door of the place being firſt ſhut, leſt thoſe who have ſtrength and ſenſe remaining ſhould eſcape.

In deſtroying rats, advantage may be taken of that remarkable degree of inſtinct which they poſſeſs of deſerting one place, where they find themſelves diſturbed or haraſſed, and retiring to new haunts. It is well known, that after one or two rats are poiſoned, or taken in traps, or wounded or otherwiſe injured, and afterwards permitted to eſcape, the whole colony immediately diſappears. The practice, however, of deſtroying rats that frequent dwelling-houſes, by poiſon, ſhould be as much as poſſible avoided ; for they retire to places behind the wainſcot, &c. from which, after death, their putrid bodies emitting a moſt offenſive ſmell cannot be removed. But it is far leſs difficult than is generally imagined to ſecure the different apartments of a dwelling houſe, and even the cellars, from the inroads of rats and mice, and thus to prevent their unwelcome viſits, by ſhutting up the paſſages through which they enter. Stone and lime, when they can be applied, are effectual ; but common plaſter, by introducing pieces of broken pottery ware or glaſs, along with it, will alſo anſwer the purpoſe ; and even a piece of cork, with a pin or two ſtuck through it to prevent them from eating it away, is a complete barrier to mice entering through a hole in wood, and may even prevent the entrance of rats.

We have ſeen this method of ſhutting up the holes, as ſoon as they were opened by the induſtry of the enemy, ſteadily purſued for ſome time, attended with the fulleſt ſucceſs, even in an old houſe of conſiderable extent, and finiſhed from top to bottom with wood, ſome of which was much decayed.

Often for the ſake of food, rats and mice frequent gardens, fields, and woods, in the ſummer ſeaſon ; but, on the approach of winter, they return to their former haunts in the habitations of man ; and, accordingly, it is obſerved, that houſes which are free from thoſe vermin during the ſummer, ſwarm with them about the end of harveſt. Attention to this circumſtance in the habits of theſe animals, may be the means of ſecuring us from their viſits and depredations ; for if, at the time alluded to, every hole and cranny through which rat or mouſe can enter, be ſhut up, and carefully kept cloſe and ſecure, the perſeverance of the foe is exhauſted and overcome by repeated and conſtant reſiſtance, and thus he is forced to abandon the unequal conteſt, and to retire to other haunts where his motions are leſs interrupted.

Various other methods have been propoſed for the deſtruction of rats ; and although we have thrown out a hint againſt the uſe of arſenic for this purpoſe, in dwelling houſes ; yet where it can be employed with perfect ſafety, and without riſk of the nuiſance alluded to, as in cellars and outhouſes, it is undoubtedly one of the moſt effectual to which we can have recourſe.

Suffocating theſe vermin by means of the fumes of ſulphur, as on board of ſhips, in granaries and other buildings which can be ſhut up, is ſometimes alſo ſucceſsfully,

ceſsfully practiſed. Rats and other vermin have alſo been effectually deſtroyed and eradicated by burning wood in cloſe apartments, thus producing fixed air or carbonic acid gas, by which they are alſo ſuffocated.

Moles.—Various methods have been propoſed for the deſtruction of theſe animals. But the following obſervations on this ſubject, which we ſhall give in the words of the author, ſeem to be more ſatisfactory than any thing we have met with.

“ The great damage (ſays he) which moles occaſion in cultivated land, and particularly gardens, is well known; and the beſt means of remedying this evil is by deſtroying all thoſe that make their appearance, as far poſſible. The ſecrets which quacks ſell for extirpating theſe deſtructive animals are of very little avail; and even poiſon produces no effect, as the mole does not drink, and lives only on roots and worms. In regard to gins and traps, the moles muſt be enticed to them by ſome kind of bait, which does not always produce the intended effect. Buffon advices a trench to be dug around the hills under which they conceal themſelves, and thus to cut them off from all communication with the neighbouring ground. This method requires three or four people to dig trenches; and though it may prove effectual, it is attended with too much trouble. The other methods propoſed by different naturaliſts are neither eaſier nor more certain.

“ It is well known that this animal lives under the earth; and if at any time it comes forth from its holes, it is only when compelled to do ſo, in conſequence of large quantities of water accumulated after the heavy rains which fall in ſummer, or when the earth is ſo much parched and dried by the continued drought, that it can no longer continue its labour; but it again creeps back into the earth when it finds a ſpot convenient for its purpoſe.

“ This animal, as already remarked, feeds upon roots and worms, and for this reaſon is generally found in rich fertile ſoil; but never in that which is marſhy or ſtony. In the winter time it retires to elevated places, becauſe it is there beſt ſecured from inundations. In ſummer, however, it deſcends to the low hillocks and flat land, and above all makes choice of meadows for the place of its reſidence; becauſe it finds the earth there freſher and ſofter for it to dig through. If the weather continues long dry, it repairs to the borders of ditches, the banks of rivers and ſtreams, and to places contiguous to hedges.

“ The mole breeds generally at the beginning of winter, and the months when they are found big with young are January and February. In the month of April a great many of their young may be ſeen. Among 122 caught in the month of May by my method, there were only four big with young. This animal cannot live without digging; it is obliged to find its nouriſhment in the bowels of the earth; and on that account is under the neceſſity of making thoſe long ſubterranean paſſages which are found between one mole-hill and another. In general it begins to dig five or ſix inches under the ſurface; it ſcrapes the earth before it on one ſide till the quantity becomes too great for it to labour with eaſe; it then works towards the ſurface; and by puſhing with its head, and the aſſiſtance of its nervous paws, gradually raiſes up the earth which incommodes it, and which produces thoſe ſmall hills ſo common in fields. After getting rid of the earth in this manner, it proceeds forwards, and continues its labour as before. The farther it goes the more hills are produced. At each period of its labour it throws up four or five.

“ In places overgrown with graſs and ſhrubs, the mole is often contented with only forcing a paſſage through between the roots; and when the earth in gardens has been newly watered, it keeps itſelf at the depth of ſcarcely half an inch under the ſurface. This animal ſhews an equal averſion to great cold and violent heat; and in order to avoid both, it forces its way, when either prevail, to the greateſt depth in the earth.

“ It continues its labour at all times, becauſe it is neceſſary for it to procure nouriſhment. It is abſolutely falſe that it ſleeps throughout the winter, as ſome naturaliſts have aſſerted; for it throws up the earth in the coldeſt ſeaſon, as well as during the ſummer. It is moſt buſily employed towards the end of winter, and at that period forms the greateſt number of hills. To this it is impelled by more than one reaſon. In the firſt place, it muſt provide nouriſhment for its young; ſecondly, it finds it eaſieſt at that time to dig its way through the earth; and laſtly, as the air begins to be milder, the animal then recovers that ſtrength which it had loſt during the intenſe cold. At this ſeaſon, therefore, it is moſt proper to purſue means for extirpating this animal, as it can be deſtroyed with greater eaſe while employed at its labour.

“ The male is much ſtronger than the female, and the hills thrown up by the former are much larger as well as more numerous. The periods when the mole is moſt buſily employed in digging are in the morning, at ſunriſe, at noon, and at ſunſet. In dry weather moles are obſerved to throw up the earth for the moſt part only at ſunriſe, and in winter when the earth has been ſomewhat heated by the ſun's rays.

“ A perſon may eaſily diſcover how many moles are contained in a certain ſpace of ground, by counting the freſh raiſed mole-hills which have no communication with each other. I muſt remark alſo, that this animal has very bad ſight, being almoſt totally blind; but its hearing, on the other hand, is ſo much the more acute.

“ I ſhall now proceed to the method of deſtroying them. Immediately at day-break it will be neceſſary to make a tour round the garden or meadow, from which it is wiſhed to extirpate the moles; for at that time they will be all found at work, as may be ſeen by the hills newly thrown up. If the perſon is then cloſe to the hill, he muſt proceed as the gardeners do, and turn up with a ſtroke of the ſpade the hill together with the digger. The paſſage is then cut through before the animal is aware of the attack, and therefore it has not power to eſcape. If the mole-hill be freſh, even though the animal may not be throwing up earth, the perſon ought not to loſe his time in waiting, but ſhould immediately proceed to the operation above mentioned.

“ If you find a freſh hill ſtanding by itſelf, which ſeems to ſhew by its ſituation that it has no communication with any other, which is always the caſe when the mole has worked from the ſurface downwards in endeavouring to procure a more convenient habitation, after the hill has been turned up with the ſpade, a bucket of water ſhonld be poured over the mouth of the paſſage. By theſe means the animal, which is at no great diſtance, will be obliged to come forth, and may be eaſily caught with the hand.

"You may diſcover alſo whether a hill has any communication with another, if you apply your ear to it, and then cough or make a loud noiſe. If it has no communication with the neighbouring hills, you will hear the terrified animal make a noiſe by its motion. It will then be impoſſible for it to eſcape; and you may either pour water into the hole, or turn up the hill with a ſpade until the mole is found; for in general it never goes deeper into the earth than from fifteen to eighteen inches.

"When any of the beds in a garden have been newly watered, the mole, attracted by the coolneſs and moiſture, readily repairs thither, and takes up its reſidence in them, making a paſſage at the depth of ſcarcely an inch below the ſurface. In that caſe it may be eaſily caught. When you ſee it at work, you need only tread behind the animal with your feet on the paſſage to prevent its retreat, and then turn up the hill with a ſpade; by which means you will be ſure to catch it.

"When you dig after it with a ſpade, the animal forces its way downwards into the earth in a perpendicular direction, in order that it may better eſcape the threatened danger. In that caſe it will not be neceſſary to dig long, but to pour water over the place, which will ſoon make the animal return upwards.

"People in general are not aware of the great miſchief occaſioned in fields and gardens by theſe animals. We are, however, informed by Buffon, that in the year 1740 he planted 15 or 16 acres of land with acorns, and that the greater part of them were in a little time carried away by the moles to their ſubterranean retreats. In many of theſe there were found half a buſhel, and in others a buſhel. Buffon, after this circumſtance, cauſed a great number of iron traps to be conſtructed, by which in leſs than three weeks he caught 1300. To this inſtance of the devaſtation occaſioned by theſe animals, we may add the following: In the year 1742 they were ſo numerous in ſome parts of Holland, that one farmer alone caught between five and ſix thouſand of them. The deſtruction occaſioned by theſe animals is, however, no new phenomenon. We are informed by hiſtory, that the inhabitants of the iſland of Tenedos, the Trojans, and the Æolians, were infeſted by them in the earlieſt ages. For this reaſon a temple was erected to Apollo Smynthius, the deſtroyer of moles.

Inſects.—Many inſects, in the different ſtates of exiſtence through which they paſs, are exceedingly troubleſome and deſtructive. Sometimes they ſpread their devaſtations in the ſtate of *larva* or *grub*, and ſometimes in that of perfect inſect.

Of the coleopterous inſects, the grub of the cockchaffer, which is a browniſh or cheſnut-coloured beetle, commits the greateſt ravages. This beetle appears during great part of the ſummer, the moſt plentiful in May or June, and hence called the *May bug*. It flies only in the evening, and lodges during the day under the leaves of trees, which it devours, and is ſometimes in ſuch numbers, as to defoliate whole woods. The beetle depoſits its eggs in the earth, and from theſe are hatched white or bluiſh grubs, that feed on the roots of graſs, corn, and other vegetables, during the whole ſummer. In the winter they lie deep in the earth; but in the ſpring, as vegetation advances, they riſe to the ſurface, and renew their work of deſtruction. In this ſtate they continue for four, five, or ſix years, before they change to the chryſalis ſtate, in which they remain till the month of May, when the perfect inſect appears. As theſe inſects require ſo many years to aſſume the perfect form, they only appear occaſionally ſufficiently numerous to be extenſively deſtructive to the crops of grain, or vegetables in general. Their numbers, however, have often produced great alarm, and even excited the attention of governments to offer rewards for an effectual method of deſtroying them.

In the ſpring ſeaſon, if the weather prove warm, when the land is ploughed up, theſe grubs are generally ſo near the ſurface as to be turned up with the plough; and being thus expoſed, they are picked up and devoured by various birds, which, it is ſuggeſted, ſhould not be diſturbed or driven away in this ſalutary labour. When theſe grubs infeſt meadow land, it has been propoſed to drown them in their holes by overflowing it. But it is ſuppoſed that this plan would not be ſucceſsful, even where it is practicable, unleſs there is a bed of clay immediately under the ſoil, to retain the water for a ſufficient length of time. A more efficacious way is recommended to prevent the increaſe of the grubs, by deſtroying the flies in May or June, before they have depoſited their eggs. This may be done by ſhaking and beating the trees and hedges in the middle of the day; and, as this is a work which may be performed by children, it is a leſs difficult taſk than would at firſt ſight be imagined. Domeſtic fowls are remarkably fond of theſe beetles, ſo that a double object is thus gained, the deſtruction of the beetles and the procuring of food for the poultry.

Some ſpecies of the dermeſtes, and alſo of the genus *ptinus*, are exceedingly deſtructive in the cabinets of naturaliſts, and alſo to furniture. Various methods have been recommended to ſtop their ravages. We believe the moſt effectual is ſpirit of turpentine, when it can be properly applied. A ſolution of corroſive ſublimate is ſometimes employed, but it ſhould be recollected that it ſeldom fails in time to produce ſome chemical change on animal and vegetable matters. Objects of natural hiſtory as birds, animals, &c. are ſometimes expoſed to the moderate heat of an oven, or before a fire, for ſeveral hours; but this method will alſo be attended with injurious effects, unleſs practiſed with great care. Inſects which infeſt furniture have been deſtroyed by the application of oil, and allowing it to remain for a day or two, before the furniture is rubbed up. Japanned or varniſhed furniture may be ſecured from the effects of theſe inſects, by re-coating it, when they are in the larva ſtate, by which they are deprived of air. Railing, and other works out of doors, which are expoſed to the weather, are ſometimes eaten with inſects, and particularly by ſome of the larvæ of the genus *curculio*. The wood thus attacked may be prevented from farther ravages, by a freſh coat of paint.

The earwig is a deſtructive inſect in the flower, kitchen, and fruit garden. To prevent their depredations, it has been recommended to take them by the hand, when they come out during the night in ſearch of food. They may be taken alſo by rolling up a piece of paper, and hanging it up on the plants which they infeſt; for in theſe places they take ſhelter through the day. Another method of deſtroying them has been mentioned, and that is to watch them towards morning with the view of diſcovering the haunts to which

they

they reſort during the day; and this diſcovery being made, which may perhaps be a melon frame, dunghill, or heap of rubbiſh, the removing of which will deſtroy the greater number of theſe troubleſome inſects.

The ſmall inſect which commits ſuch depredations among turnips, by eating the ſeedling leaves as ſoon as they appear, as frequently to deſtroy whole crops, is ſuppoſed to be a ſmall black poliſhed beetle, belonging to the genus *chryſomela*. It does not ſeem to be well aſcertained whether this ſmall beetle, which is better known by the name of turnip fly, commits its ravages in the larva or in the beetle ſtate. It is ſaid that it prefers the leaves of the common radiſh to thoſe of the turnip, and it is therefore recommended to ſow radiſhes along with the turnips, to prevent the deſtruction of the latter.

Of the inſects belonging to the order hemiptera, there are ſome which are exceedingly deſtructive. The cock-roach, a native of the warmer parts of America and the Weſt Indies, is a very troubleſome, and a very voracious inſect. It has been introduced into this country, and particularly into the ſeaport towns, in conſequence of commercial intercourſe. It comes out to feed in the night-time, and eats almoſt of every thing that comes in its way. Cock-roaches are eaſily taken by the following method. Cover the outſide of a deep glaſs or baſon with paper; introduce ſome bits of bread or ſugar into the baſon or glaſs, and ſet it in a place frequented by the cock-roaches. They creep up by means of the paper on the outſide, and drop into the veſſel; but in conſequence of its ſmooth poliſhed ſurface, they cannot effect their eſcape. In the ſame way crickets and beetles may be taken and deſtroyed. It is quite unneceſſary to ſpeak of the means of deſtroying the myriads of locuſts which not unfrequently infeſt eaſtern countries, and particularly Egypt and Syria; for no means are likely to be deviſed, which promiſe to reſiſt the effects of ſuch a hoſt of foes, by whoſe ravages every green thing is conſumed; but the inſect itſelf becomes, among the poorer inhabitants of thoſe countries, a partial ſubſtitute for the fruits of the earth which it has deſtroyed. The inſects are taken, reduced to powder, and converted into a kind of meal.

The common or the bed-bug is a very troubleſome, and a very common inmate in the crowded houſes of many large towns in this country. Its uſual haunts are the crevices of wood, and particularly thoſe pieces of furniture which are uſually kept in the warmeſt corners of the apartment. Cleanlineſs will perhaps be found the beſt preſervative againſt the introduction and increaſe of theſe inſects; but ſometimes even the greateſt care and attention are ineffectual in keeping houſes entirely free from them. When it can be conveniently done, they are completely deſtroyed by immerſing the furniture in boiling water, or by baking it in an oven; and by filling up the crevices or holes which were their haunts, with glaziers putty, their return and increaſe will thus be prevented. But a very effectual method of deſtroying bugs, is to waſh the places which they frequent with ſpirit of turpentine, and then filling up the holes as already mentioned. It is a curious circumſtance in the hiſtory of theſe inſects, that ſome perſons entirely eſcape from their attacks, while to others they are exceedingly troubleſome and diſtreſſing. It is ſaid that lavender-water, ſprinkled over the bed-clothes, often prevents their approach. How far this is the caſe, we have had no opportunity of aſcertaining.

The ſmall moth, which in the caterpillar ſtate commits ſuch ravages on woollen cloths, furs, and other animal ſubſtances, which remain for any length of time in dark undiſturbed places, may be deſtroyed with the greateſt certainty and facility, by expoſing the ſubſtances on which they are ſuſpected to make their depredations, to the vapour of ſpirit of turpentine, or bruſhing them with a bruſh dipped into the ſame fluid. This ſhould be done about the months of September or October; but their effects may be prevented by placing the cloths, furs, &c. which are likely to become their reſidence, in an airy ſituation, about the months of July and Auguſt.

The different kinds of lice are very numerous. Every animal has its peculiar ſpecies, and even mankind are not free from this peſt. It is often the conſequence of indolence and naſtineſs, and it is obſerved that the lice which infeſt any animal increaſe prodigiouſly when that animal becomes languid and ſickly. We believe that the application of ſpirits of turpentine, already ſo often recommended, would alſo be effectual in this caſe; but mercurial preparations afford a certain remedy againſt theſe inſects. For this purpoſe a very ſmall quantity of what is called mercurial ointment may be employed. At the ſame time it ought to be recollected, that cleanlineſs is the beſt preſervative. A ſingular notion prevails in this country, and even among perſons who are by no means in the loweſt rank of life, that it is a good ſign of health when children's heads are infeſted with theſe animals; and on this account they are not very anxious in having them entirely eradicated. A moment's reflection may ſhow the abſurdity of ſuch an opinion, ſo that it would be a waſte of time to adduce ſerious arguments againſt it.

It is perhaps more difficult for mankind to ſecure themſelves and their habitations from the viſits of the common flea. Cleanlineſs, however, may do much even in effecting this; and in particular it appears to us, that it would be extremely uſeful, frequently to rub up with a piece of cloth the more inacceſſible parts of furniture or apartments, or perhaps it would anſwer better to employ a ſmall hard bruſh. By the leſs acceſſible places we mean the corners and crevices of rooms and furniture where duſt is apt to collect, and eſpecially the canvas part of a bed. We are perſuaded that ſpirits of turpentine might alſo be found uſeful for the deſtruction of theſe very troubleſome inſects. The Scotch myrtle (*myrica gale*, Lin.) a plant very common in low and moiſt mooriſh places in this country, is ſaid to be an excellent remedy, in conſequence of its powerful aromatic odour, againſt the attacks of theſe animals. For this purpoſe, the plant is ſtrewed about the apartment or bed which is infeſted with fleas.

The following method of deſtroying or driving away all kinds of noxious vermin from fields and gardens, it is ſaid, has been proved by experience to be effectual. It is recommended by M. Socoloff, and the account of it is taken from the Peterſburgh Tranſactions *. As the deſtructive power of quicklime (ſays the author), heightened by a fixed alkali, which corrodes, diſſolves and deſtroys all the tender parts of animals, has been long known, I thought this mixture would be the beſt means for accompliſhing the object I had in view. I took three

* *Phil. Mag.* i. 169.

three parts, therefore, of quicklime, newly made, and two parts of a ſaturated ſolution of fixed alkali in water, and thence obtained a ſomewhat milky liquor ſufficiently cauſtic, highly hoſtile and poiſonous to earth-worms and other ſmall animals; for, as ſoon as it touched any part of their bodies, it occaſioned in them violent ſymptoms of great uneaſineſs. If this liquor be poured into thoſe holes in which the earth-worms reſide under ground, they immediately throw themſelves out as if driven by ſome force; and, after various contorſions, either languiſh or die. If the leaves of plants or fruit-trees, frequented by the voracious caterpillars, which are ſo deſtructive to them, be ſprinkled over with this liquor, theſe inſects ſuddenly contract their bodies and drop to the ground. For, though nature has defended them tolerably well by their hairy ſkins from any thing that might injure their delicate bodies, yet, as ſoon as they touch with their feet or mouths leaves which have been moiſtened by this liquor, they become as it were ſtupefied, inſtantly contract themſelves, and fall down.

"I had not an opportunity of trying a like experiment on locuſts; yet we may conclude, and not without probability, from their nature and the general deſtructive qualities of the above liquor, that they, in like manner, may be driven from corn-fields, if it be poſſible to ſprinkle the corn with the liquor by means of a machine.

"With regard to plants or corn, theſe ſuſtain no injury from the liquor, becauſe it has no power over the productions of the vegetable kingdom, as I have fully learned from experience; or, if any hurt be ſuſpected, all the danger will be removed by the firſt ſhower that falls. This liquor may be procured in abundance in every place where lime is burnt. If the lime be freſh, one part of it infuſed in about ſeventy parts of common water will produce real lime-water. The want of the fixed alkali may be ſupplied by boiling wood aſhes in water, and thickening the ley by evaporation.

"The liquor might be employed alſo to kill bugs and other domeſtic inſects which are noxious and troubleſome; but on account of its ſtrong lixivious ſmell, which diſpoſes the human body to putridity, I dare not recommend the uſe of it in houſes that are inhabited. Beſides, bugs may be eaſily got rid of, as I have repeatedly found from experience, by the oily pickle that remains in caſks in which ſalted herrings have been packed. To this liquor they have a ſtrong averſion; and, if they are moiſtened with it, they die in a very ſhort time [*]."

For deſtroying inſects and caterpillars, which infeſt fruit trees, the following method is recommended as having been ſucceſsfully practiſed. The author obſerves that "The preſent year, for inſtance, (1805), offers a ſingularity which I have not before perceived. In ſome diſtricts the cherry-tree has experienced, at the time of its bloſſoming, colds and winds which have prevented it from ſetting; but another plague, not leſs diſaſtrous, has attacked the cherry-trees and plum-trees over ſeveral diſtricts in France. Great ſwarms of little animals reſembling *vine-fretters*, but which are not ſo in reality, eſtabliſhed their habitations at the extremity of the branches of the cherry-trees. As ſoon as a branch was attacked, the leaves curled, and the juice was dried up, On opening the leaf, a conſiderable number of ants was diſcovered, which, jointly with the inſect which began the ravages, ſucked the branch, and made it wither. What I have remarked is, that uſually, when the vine-fretters attack any tree, the neighbouring tree very ſoon experiences the ſame fate; but the attack of this year is only partial. In an alley of cherry-trees which I poſſeſs ſeven trees have been attacked, but not thoſe which are next each other. One tree was placed between two which were very much damaged by theſe inſects, and yet this one was not hurt.

"On theſe vermin the ſmoke of tobacco had no effect at all: this convinces me that they are different from the ordinary kind.

"Plum-trees, when attacked by the ſame inſect, do not loſe their fruit like the cherry-trees; but the little animals cover them with more rapidity, ſo as to extirpate even the appearance of fruit.

"Having effectually watered a plum-tree, I covered it with aſhes, in the manner we treat beans and cabbages, and the vermin were deſtroyed: but this is only practicable with a tree of low height.

"I made one remark, which I think is eſſential to communicate: it is, that plum-trees planted in ground which is not neceſſarily watered, are leſs attacked by theſe inſects than thoſe which have experienced a humidity communicated by the plants in their neighbourhood. to which watering is abſolutely neceſſary. I had one planted in a bed of artichokes: we know very well that this plant requires plenty of water; and the tree was entirely covered with inſects. Its leaves withered, and the fruit fell off; while two other plum-trees, in ground not watered at all, were much leſs attacked. This convinces me that theſe were not the ordinary vermin abundant in dry ſeaſons.

"I was only able to protect my cherries a little, by cutting off the extremities of the damaged branches.

"Several people had recourſe to ſulphur; but I did not follow that method. The ſmoke of ſulphur deſtroys the inſect, I admit, but it is at leaſt equally dangerous to the tree; I always prefer an aſperſion of the tree with ſoap-ſuds. This very year I experienced the good effects of it. I ſaw my plum-trees look green again, and the inſects abandon them. The aſperſion is very eaſily managed, by means of watering-pots or ſmall garden-engines. I have alſo employed a ley of wood-aſhes with the ſame ſucceſs as ſoap and water.

"An obſervation equally important which I have made is, the great damage done this ſeaſon in all orchards by the caterpillar. As ſoon as they devoured the young leaves, they attacked the fruit. In ſpite of the great care taken in ſpring to get rid of them, the number of theſe inſects is incredible. I have ſeen them unite on the large branches, fix their neſts to them, and protect them by means of the downy matter which covers the buds of the enſuing ſeaſon. Whatever precaution is taken, it is almoſt impoſſible not to deſtroy theſe buds. It is only neceſſary to take off theſe neſts and burn them; and this is the only way of getting rid of the coveys. I employed the ſame aſperſion for my apple-trees, and by that means got rid of their enemies alſo[*].

"The following methods are practiſed in Germany for freeing granaries from mites or weevils:

"1. Cover completely the walls and rafters, above and below, of the granaries which are infeſted by weevils,

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[*] Phil. Mag. i. 169.

[*] Phil. Mag. xxiv. 213.

vils, with quicklime ſlaked in water in which trefoil, wormwood, and hyſſop have been boiled. This compoſition ought to be applied as hot as poſſible.

“ 2. A very ſagacious farmer has ſucceeded in deſtroying weevils by a very eaſy proceſs. In the month of June, when his granaries were all empty, he collected great quantities of the largeſt-ſized ants in ſacks, and then ſcattered them about the places infeſted with the weevils. The ants immediately fell upon and devoured every one of them; nor have any weevils ſince that time been ſeen on his premiſes.

“ 3. Another method, not leſs efficacious, but which requires a great deal of care and attention in the application of it, is the following:—Place in your granaries a number of chafing-diſhes filled with lighted pieces of wood. Every aperture muſt then be carefully cloſed, in order to prevent any freſh air from entering. The carbonic acid gas, produced from the burning wood, proves fatal to the inſects. Rats and mice, alſo, are ſo ſtrongly affected by it, that they are ſeen running out of their holes, and dying in all directions. The perſons employed to manage this proceſs muſt take great care of their own ſafety, by keeping a current of air around them until the burning wood is properly placed. Another danger may ariſe from the premiſes taking fire; but this alſo may be avoided by proper caution, particularly if they are paved with brick or ſtone *.”

Grain, it is ſaid, has been preſerved from weevils and other deſtructive inſects, by covering the heaps with pieces of hemp cloth dipped in water and wrung out. At the end of two hours the weevils are found adhering to the cloths, which are to be removed carefully and plunged in water for ſome time to drown. A plant of henbane placed in the middle of a heap of grain is ſaid alſo to drive away the inſects. They muſt then be watched and deſtroyed as they attempt to eſcape.

Sulphur or flower of brimſtone is recommended as being an excellent remedy againſt the effects of inſects on plants. It may be applied by duſting the leaves affected, either by tying it up in muſlin cloth, or with a puff for hair powder, or with a dredging box. But the ſulphur not only deſtroys the worms and inſects which infeſt trees; it ſeems alſo to render the trees more healthy and vigorous. This was particularly the caſe with ſome peach trees on which it was ſprinkled,

The following method, diſcovered by M. Catin, is propoſed for deſtroying earth-fleas, bugs, ants, &c.

“ Take black ſoap, of the beſt kind, one pound three quarters, the ſame quantity of flowers of ſulphur, muſhrooms two pounds, and ſixty meaſures of river or rain-water. Divide the water into two parts, one of which muſt be poured into a veſſel deſtined for that purpoſe: ſuffer the ſoap to diſſolve in it, and add the muſhrooms after they have been a little pounded. Boil the other half of the water in a kettle, and tie up the ſulphur in a bit of rag or piece of fine linen, and ſuſpend from it a ſufficient weight in order that it may ſink in the water. During the time the water is kept boiling, which muſt be at leaſt twenty minutes, ſtir it continually with a ſtick, and preſs the bag containing the ſulphur, that the latter may be forced out into the water, and communicate to it the neceſſary ſtrength and colour.

“ When the liquor is taken from the fire, pour it directly into the caſk, and ſtir it round for a conſiderable time: the proceſs of ſtirring muſt be repeated daily till it acquire a fetid ſmell. Experience has ſhown that the more fetid the mixture is, its activity is the greater. Each time that the mixture is ſtirred, the caſk muſt be ſtopped immediately after. When you wiſh to uſe the liquid, nothing is neceſſary but to ſprinkle a little of it on the plants which you are deſirous of preſerving, or to dip their branches in it. It will be better, however, to make uſe of a ſyringe, having at the end a head, an inch or an inch and a half in diameter, pierced with ſmall holes. This inſtrument may be uſed for tender plants; when you apply the liquid to trees, a ſyringe with larger holes muſt be employed.

“ Caterpillars, beetles, earth-fleas, bugs, and the tree-lice which infeſt orange trees, will be deſtroyed by the firſt application of the liquid. Inſects which reſide below the earth, ſuch as waſps, hornets, ants, &c. require that the liquid ſhould be ſquirted out gently, and without intermiſſion, that it may better penetrate to their neſts. Ants neſts, according to their ſize, require from two to three meaſures of liquid, and in many caſes it muſt be applied for twenty-four hours. When the ants aſſemble in another place, the proceſs muſt be repeated. Two ounces of *nux vomica* may be added to the mixture, and boiled along with the ſulphur. This ſubſtance, particularly when you wiſh to deſtroy ants, will be of great ſervice. When the whole of the liquid in the caſk has been uſed, the reſiduum muſt be buried in the earth to prevent domeſtic animals from eating it *.”

The uſe of elder as a preſervative to vegetables againſt the depredations of inſects is detailed in the following obſervations.

“ Common elder has appeared to me uſeful, 1ſt, For preventing cabbage plants from being devoured or damaged by caterpillars; 2d, To prevent blights, and their effects on fruit and other trees; 3d, To preſerve corn from yellow flies and other inſects; 4th, To ſecure turnips from the ravage of flies, &c.

“ 1ſt, The ſtrong and fetid odour of a bunch of elder leaves induced me to think that different kinds of butterflies might be incommoded by it in proportion to their delicacy. I therefore took ſome young twigs of elder, at the period when butterflies began to appear, and whipped well with them ſome cabbage plants, but in ſuch a manner as not to damage them. Since that time, during two ſummers, though the butterflies hovered round the plants, I never ſaw one of them ſettle on them; and I do not think that a ſingle butterfly was hatched on the cabbages treated in this manner, though a neighbouring board was dirtied by them in the uſual manner.

“ 2d, After a ſhort reflection on the effects here mentioned, and on blights, which, in my opinion, are chiefly occaſioned by ſmall flies and ſmall inſects, whoſe organs are ſtill more delicate than thoſe of the former, I was induced to whip in the ſame manner with elder twigs, as high as I could reach, the branches of a plum-tree which grew in an eſpalier. The whipped leaves remained green and in a good condition, while from at leaſt ſix inches above to the top of the tree the reſt of the leaves were blighted, wrinkled, and full of worms. It is here to be obſerved that the tree was in full flower when I whipped it, therefore much too late for this operation, which ought to have been performed once or twice before flowering. But I am of opinion, that if trees were beſprinkled with a ſtrong infuſion of elder every

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* Phil. Mag. xxvi. 91.

* Phil. Mag. vii. 189.

every eight or 15 days, the ſucceſs would be certain, and that there would be no danger of injuring either the flowers or the fruit.

3d, What the farmers call the yellows in corn, and which they conſider as a kind of blight, is the effect, as every one knows, of a ſmall yellow fly with blue wings, nearly of the ſize of a gnat. It lays its eggs in the ear of wheat, and produces a worm almoſt inviſible to the naked eye, but which, when ſeen by a magnifying glaſs, is a large yellow larva, having the ſhining colour of amber. This fly is ſo productive, that I have counted upwards of forty worms in the chaff of one ear of wheat, which was a number ſufficient to deſtroy it entirely. I therefore propoſed to make my experiment as ſoon as poſſible; but the heat and drought of the ſeaſon having advanced the wheat more than uſual, it was in flower before I could attempt it. Next morning, however, at break of day, two ſervants having drawn bundles of elder over the ears of wheat on each ſide of the furrow, backwards and forwards, in places where the wheat was not ſo far advanced, I hoped that the fetid effluvia of the elder would prevent the flies from remaining on the ears that were covered with them: and, indeed, I was not entirely diſappointed; for, on examining my wheat ſome time after, I found that the part which had been beaten with elder was much leſs damaged than that which had not been treated in the ſame manner. I have no doubt, that, had I employed this precaution ſooner, the corn would have been completely preſerved. Should this be the caſe, the proceſs is ſimple; and I flatter myſelf that fine crops of corn may be ſaved by theſe means from this ſmall inſect, which is ſo deſtructive to them. One of theſe yellow flies laid on my thumb at leaſt eight or ten eggs, of an oblong form, in the ſmall interval of time which I employed in walking over two or three furrows, holding it by the wings, and which I could not obſerve without the aſſiſtance of a magnifying glaſs.

"4th, It often happens that whole crops of turnips are deſtroyed while young, in conſequence of being pricked by certain inſects. I have great reaſon to think that this evil may be prevented in an effectual manner, by cauſing a perſon to draw a bunch of elder, ſufficiently large to cover about the breadth of a foot, over the young turnips, going backwards and forwards. What confirms me in this idea is, that, having drawn a bunch of elder over a bed of young cauliflowers which had begun to be pricked, they afterwards remained untouched by theſe inſects.

"Another fact which tends to ſupport this idea is, that when my neighbourhood, about eight or nine years ago, was ſo infeſted with caterpillars that they devoured all the vegetables, leaving ſcarcely a green leaf untouched, they ſpared the elder trees amidſt this general devaſtation, and never moleſted them. In reflecting on theſe circumſtances, I am of opinion that the elder might be introduced with advantage into our gardens, as the means of preſerving fruit-trees and various plants from the rapacity of inſects.

"The dwarf elder appears to me to exhale a much more fetid ſmell than the common elder, and therefore ought to be preferred in making experiments on this ſubject *."

VERNACULAR, a word applied to ſomething that is peculiar to any one country.

VERNAL, ſomething belonging to the ſpring-ſeaſon.

VERNIER SCALE, a ſcale excellently adapted for the graduation of mathematical inſtruments, thus called from its inventor Peter Vernier, a perſon of diſtinction in the Franche Comté. See NONIUS.

Vernier's method is derived from the following principle. If two equal right lines, or circular arcs, A, B, are ſo divided, that the number of equal diviſions in B is one leſs than the number of equal diviſions of A, then will the exceſs of one diviſion of B above one diviſion of A be compounded of the ratios of one of A to A, and of one of B to B.

For let A contain 11 parts, then one of A to A is as 1 to 11, or $\frac{1}{11}$. Let B contain 10 parts, then one of B to B is as 1 to 10, or $\frac{1}{10}$. Now $\frac{1}{10}-\frac{1}{11}=\frac{11-10}{10\times 11}=\frac{1}{10\times 11}=\frac{1}{10}\times\frac{1}{11}$.

Or if B contains n parts, and A contains $n+1$ parts; then $\frac{1}{n}$ is one part of B, and $\frac{1}{n+1}$ is one part of A. And $\frac{1}{n}-\frac{1}{n+1}=\frac{\overline{n+1}-n}{n\times\overline{n+1}}=\frac{1}{n}\times\frac{1}{n+1}$.

The moſt commodious diviſions, and their aliquot parts, into which the degrees on the circular limb of an inſtrument may be ſuppoſed to be divided, depend on the radius of that inſtrument.

Let R be the radius of a circle in inches; and a degree to be divided into n parts, each being $\frac{1}{p}$th part of an inch.

Now the circumference of a circle, in parts of its diameter 2R inches, is $3{,}1415926\times 2R :: 1^{\circ} : \frac{3{,}1415926}{360}\times 2R$ inches.

Or, $0{,}01745329\times R$ is the length of one degree in inches.

Or, $0{,}01745329\times R\times p$ is the length of 1°, in pth parts of an inch.

But as every degree contains n times ſuch parts, therefore $n=0{,}01745329\times R\times p$.

The moſt commodious perceptible diviſion is $\frac{1}{8}$ or $\frac{1}{10}$ of an inch.

Example. Suppoſe an inſtrument of 30 inches radius, into how many convenient parts may each degree be divided? how many of theſe parts are to go to the breadth of the vernier, and to what parts of a degree may an obſervation be made by that inſtrument?

Now $0{,}01745\times R=0{,}5236$ inches, the length of each degree: and if p be ſuppoſed about $\frac{1}{8}$ of an inch for one diviſion; then $0{,}5236\times p=4{,}188$ ſhows the number of ſuch parts in a degree. But as this number muſt be an integer, let it be 4, each being 15″: and let the breadth of the vernier contain 31 of thoſe parts, or $7\frac{3}{4}^{\circ}$, and be divided into 30 parts.

Here $n=\frac{1}{4}$; $m=\frac{1}{30}$; then $\frac{1}{4}\times\frac{1}{30}=\frac{1}{120}$ of a degree,

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* Phil. Mag. xv. 63.

gree, or 30′, which is the leaſt part of a degree that inſtrument can ſhow.

If $n = \frac{1}{5}$, and $m = \frac{1}{36}$; then $\frac{1}{5} \times \frac{1}{36} = \frac{60}{5 \times 36}$ of a minute, or 20″.

The following table, taken as examples in the inſtruments commonly made from 3 inches to 8 feet radius, ſhows the diviſions of the limb to neareſt tenths of inches, ſo as to be an aliquot of 60's, and what parts of a degree may be eſtimated by the vernier, it being divided into ſuch equal parts, and containing ſuch degrees as their columns ſhow.

Rad. inches.	Parts of a degree.	Parts in vernier.	Breadth of vernier.	Parts obſerved.	
3	1	15	$15\frac{1}{4}$	4′	0″
6	1	20	$20\frac{1}{4}$	3	0
9	2	20	$10\frac{1}{4}$	1	30
12	2	24	$12\frac{3}{4}$	1	15
15	3	20	$6\frac{3}{4}$	1	0
18	3	30	$10\frac{1}{4}$	0	40
21	4	30	$7\frac{1}{4}$	0	30
24	4	36	$9\frac{3}{4}$	0	25
30	5	30	$7\frac{1}{2}$	0	20
36	6	30	$5\frac{1}{4}$	0	20
42	8	30	$3\frac{7}{8}$	0	15
48	9	40	$4\frac{5}{9}$	0	10
60	10	36	$3\frac{7}{10}$	0	10
72	12	30	$2\frac{7}{12}$	0	10
84	15	40	$2\frac{2}{3}$	0	6
96	15	60	4	0	4

By altering the number of diviſions, either in the degrees or in the vernier, or in both, an angle can be obſerved to a different degree of accuracy. Thus, to a radius of 30 inches, if a degree be divided into 12 parts, each being five minutes, and the breadth of the vernier be 21 ſuch parts, or $1\frac{3}{4}^{\circ}$, and divided into 20 parts, then $\frac{1}{12} \times \frac{1}{20} = \frac{1^{\circ}}{240} = 15''$: or taking the breadth of the vernier $2\frac{7}{12}^{\circ}$, and divided into 30 parts; then $\frac{1}{12} \times \frac{1}{30} = \frac{1^{\circ}}{360}$, or 10″: Or $\frac{1}{12} \times \frac{1}{50} = \frac{1^{\circ}}{600} = 6''$; where the breadth of the vernier is $4\frac{1}{4}^{\circ}$.

VERONA, a city of Italy, capital of the Veroneſe, and in the territory of Venice; ſituated on the river Adige, in E. Long. 11. 24. N. Lat. 45. 26. It is ſeven miles in compaſs; and is ſtrongly fortified. It contains 57.400 inhabitants.

VERONESE, a territory of Italy, in the republic of Venice; bounded on the north by the Trentino, on the eaſt by the Vicentino and Paduano, on the ſouth by the Mantuano, and on the weſt by the Breſciano. It is about 35 miles in length, and 27 in breadth; and fertile in corn, wine, fruits, and cattle.

Veronese. See Cagliari.

VERONICA, a genus of plants of the claſs of diandria; and in the natural ſyſtem arranged under the 40th order, *Perſonatæ*. See Botany *Index*.

VERSAILLES, a town of France, in the department of Seine and Oiſe, 10 miles weſt-ſouth-weſt of Paris. It contains 60,000 inhabitants, and ſince the Revolution has been created a biſhop's ſee. In the reign of Louis XIII. it was only a ſmall village. This prince built here a hunting-hut in 1630, which Baſſompierre calls "the paltry chateau of Verſailles." Although the ſituation was low and very unfavourable, Louis XIV. built a magnificent palace here, which was the uſual reſidence of the kings of France till the 6th of October 1789, when the late unfortunate Louis XVI. and his family were removed from it to the Thuilleries. The buildings and the gardens are adorned with a vaſt number of ſtatues, done by the greateſt maſters, and the water-works are all worthy of admiration. The great gallery is thought to be as curious a piece of workmanſhip of that kind as any in the world: nor is the chapel leſs to be admired for its fine architecture and ornaments. The gardens, with the park, are five miles in circumference, and ſurrounded by walls. There are three fine avenues to Verſailles; one of which is the common road to Paris, the other comes from Seaux, and the third from St Cloud. E. Long. 2. 12. N. Lat. 48. 48.

VERSE, in *Poetry*, a line conſiſting of a number of long and ſhort ſyllables, which run with an agreeable cadence.

Verse is alſo uſed for a part of a chapter, ſection, &c.

VERSIFICATION, the art or manner of making verſe; alſo the tune and cadence of verſe. See Poetry, Part III.

VERSION, a tranſlation of ſome book or writing out of one language into another. See Translation.

VERT, in *Heraldry*, the term for a green colour. It is called *vert* in the blazon of the coats of all under the degree of nobles: but in coats of nobility it is called *emerald;* and in thoſe of kings *venus.* In engraving it is expreſſed by diagonals, or lines drawn athwart from right to left, from the dexter chief corner to the ſiniſter baſe.

VERTEBRÆ. See Anatomy, N° 30.

VERTEX, in *Anatomy*, denotes the crown of the head. Hence vertex is alſo uſed figuratively for the top of other things: thus we ſay, the vertex of a cone, pyramid, &c.

Vertex, is alſo uſed in *Aſtronomy* for the point of the heaven directly over our heads, properly called the *zenith.*

VERTICILLATÆ, the name of a claſs in Ray's and Boerhaave's Methods, conſiſting of herbaceous vegetables. It is alſo the name of the 42d order in Linnæus's Fragments of a Natural Method.

VERTICILLUS, a mode of flowering, in which the flowers are produced in rings at each joint of the ſtem, with very ſhort foot-ſtalks. The term is exemplified in mint, horehound, and the other plants of the natural order deſcribed above.

VERTICITY, is that property of the loadſtone whereby it turns or directs itſelf to one particular point.

VERTIGO, in *Medicine*. See there, N° 82.

VERTUMNUS, in *Mythology*, a god who preſided over gardens and orchards, honoured among the Etruſcans, from whom the worſhip of this deity was tranſmitted to the Romans.

Vertumnus had a temple near the market-place at Rome, being repreſented as one of the tutelar deities of the merchants. The commentators on Ovid ſay, that

that he was an ancient king of Hetruria, who, by his diligent and ſucceſsful cultivation of fruit and gardens, obtained the honour of being ranked among the gods.

VERUMONTANUM, in *Anatomy*, a ſmall eminence near the paſſages where the ſemen is diſcharged into the urethra.

VERVAIN. See VERBENA, BOTANY *Index*.

VERTOT d'AUBOEF, *Rene Aubert de*, a celebrated hiſtorian, was deſcended from a noble and ancient family in Normandy, and born in 1655. At 16 years of age he became a Franciſcan friar; afterwards he entered into the order of the Premonſtratenſes, in which he had ſeveral benefices: and at length was a ſecular eccleſiaſtic. He became ſecretary to the ducheſs of Orleans, member of the Academy of Inſcriptions, and hiſtoriographer of Malta. He died at Paris in 1735. His principal works are, 1. The Hiſtory of the Revolutions of Sweden. 2. The Revolutions of Portugal. 3. The Revolutions of the Romans. 4. The Hiſtory of Malta. Theſe works are written in elegant French, and tranſlated into moſt of the languages of Europe.

VERULAM. See BACON.

VESALIUS, ANDREAS, a celebrated phyſician and anatomiſt, was born at Bruſſels about the year 1512. He ſtudied phyſic at Paris under James Sylvius; but applied himſelf chiefly to anatomy, which was then very little known, diſſections being eſteemed unlawful and impious: and it appears from his work *De humani corporis fabrica*, that he perfected himſelf in this uſeful knowledge very early. About the year 1537, the republic of Venice made him profeſſor in the univerſity of Padua, where he taught anatomy for ſeven years; Charles V, called him to be his phyſician, as he was alſo to Philip II. king of Spain. Veſalius was now at the height of his glory, when all of a ſudden he formed the deſign of taking a journey to Paleſtine; concerning which journey we are told the following ſtory. A young Spaniſh nobleman he attended, being believed to be dead, Veſalius obtained leave to open him to explore the true cauſe of his illneſs; but when he opened the breaſt, he perceived ſymptoms of life, and ſaw the heart beat. The parents, not ſatisfied with proſecuting him for murder, accuſed him of impiety to the inquiſition, in hopes that tribunal would puniſh him with greater rigour: but the king interpoſing, ſaved him on condition of his making a pilgrimage to the Holy Land. He was ſhipwrecked on his return, and thrown upon the iſland of Zante, where he periſhed, in 1564. He was the author of ſeveral works, the principal of which is *De humani corporis fabrica*.

VESICATORIUM, a BLISTER; an application of an acrid nature made to any part of the body, in order to draw a flux of humours to that part, and thus elevate the ſcarfskin into a bliſter.

VESPA, the WASP; a genus of inſects belonging to the order of hymenoptera. See ENTOMOLOGY *Index*.

VESPASIAN, the 10th emperor of Rome; remarkable for his clemency and other virtues. See ROME, N° 332—339.

VESPERS, in the church of Rome, denote the afternoon ſervice; anſwering in ſome meaſure to the evening prayers of the church of England.

VESPERTILIO, the BAT; a genus of quadrupeds, belonging to the order of *primates*. See MAMMALIA *Index*.

VESSEL, a general name given to the different ſorts of ſhips which are navigated on the ocean, or in canals and rivers. It is, however, more particularly applied to thoſe of the ſmaller kind, furniſhed with one or two maſts. See SHIP.

VESTA, in pagan worſhip, the ſame with Cybele. See CYBELE.

VESTA the *Younger*, in pagan worſhip, the goddeſs of Fire, was the daughter of Saturn and Cybele, and the ſiſter of Ceres. She was ſo much in love with chaſtity, that on Jupiter's aſcending the throne and offering to grant whatever ſhe aſked, ſhe only deſired the preſervation of her virginity, which ſhe obtained.—Veſta was not repreſented in her temple by any image.

VESTA, one of the lately diſcovered planets, of which the elements have been determined by Dr Gauſs in a communication to the Royal Society of Gottingen.

Elements of Veſta.

Epoch of the longitude, meridian of Seeberg	108°	19′	34.7″		
Diurnal tropical motion			770″	85′	84
Annual	78	9	23		
Aphelion, 1806	326	37	59		
Annual motion	+	2	1.2		
Aſcending node, 1806	80	53	23		
Annual motion	+		1.5		
Inclination of the orbit, 1806	10	37	34		
Annual diminution			0.4		
Eccentricity, 1806	0.0783486				
Annual diminution	0.0000058				
Log. of the greater ſemiaxis	0.4420728				

Elements of Ceres by the ſame.

Epoch of the mean longitude at Bremen, March 29, 1807, at 12 o'clock, mean time	193°	8′	4.6″*
Longitude of its perihelion	249	7	41
———— aphelion	69	57	52
———— aſcending node on the ecliptic	103	8	36
Inclination of its orbit	7	5	49.5†
Diurnal tropical motion	0	16	18.91
Logarithm of the mean diſtance	0.3728428		
Eccentricity	0.097505		
Greateſt diſtance from the ſun	25.625		
Leaſt	21.514		
Period of its revolution	1321 days, 12 hours.		

* In the Mag. Encyclop. it is 192° 9′ 54″

† Ibid. 7° 8′ 34″

VESTALIA, in Roman antiquity, a feſtival celebrated in honour of the goddeſs Veſta, on the 5th of the ides of June: that is, on the ninth of the month.

VESTALS, among the ancient Romans, were prieſteſſes of the goddeſs Veſta, and had the perpetual fire committed to their charge; they were at firſt only four in number, but afterwards increaſed to ſix; and it does not appear that their number ever exceeded ſix, among whom was one ſuperior to the reſt, and called *veſtalis maxima*.

The veſtals were choſen from ſix to ten years of age, and obliged to ſtrict continency for 30 years; the firſt 10 of which were employed in learning the ceremonies of religion, the next 10 in the performance of them, and the 10 laſt in teaching them to the younger veſtals.

The habit of the veſtals conſiſted of a head-dreſs, called *infula*, which ſat cloſe to the head, and from whence hung certain laces called *vitta*; a kind of ſurplice made of white linen, and over it a purple mantle with a long train to it.

VESTIBLE, or VESTIBULE, in *Architecture*, a kind of entrance into a large building; being an open place before the hall, or at the bottom of the ſtaircaſe.

VESTRY, a place adjoining to a church, where the veſtments of the miniſter are kept; and alſo a meeting at ſuch place, conſiſting of the miniſter, church-wardens, and chief men of moſt pariſhes, who make a pariſh veſtry or meeting. By cuſtom there are ſelect veſtries, being a certain number of perſons choſen to have the government of the pariſh, make rates, and take the accounts of church-wardens, &c.

VESUVIAN, a mineral ſubſtance. See MINERALOGY *Index*.

VESUVIUS, a celebrated volcano of Italy, ſix miles eaſt from the city of Naples. This mountain has two tops; one of which only goes by the name of *Veſuvius*, the other being now called *Somma*; but Sir William Hamilton is of opinion, that the latter is what the ancients called *Veſuvius*.

1 General deſcription of the mountain.

The perpendicular height of Veſuvius is only 3700 feet, though the aſcent from the foot to the top is three Italian miles. One ſide of the mountain is well cultivated and fertile, producing great plenty of vines; but the ſouth and weſt ſides are entirely covered with cinders and aſhes; while a ſulphureous ſmoke conſtantly iſſues from the top, ſometimes attended with the moſt violent exploſions of ſtones, the emiſſion of great ſtreams of lava, and all the other attendants of a moſt formidable volcano. The firſt of theſe eruptions recorded in hiſtory took place in the year 79; at which time the two cities of Pompeii and Herculaneum were entirely buried under the ſtones and aſhes thrown out. Incredible miſchief was alſo done to the neighbouring country, and numbers of people loſt their lives, among whom was Pliny the Elder.

2 Account of the firſt eruption recorded in hiſtory.

It is the opinion of the beſt judges, however, that this eruption was by no means the firſt that had ever happened. The very ſtreets of thoſe cities which were at that time overwhelmed are ſaid to be partly paved with lava. Since that time 30 different eruptions have been recorded, ſome of which have been extremely violent. In the year 1538, a mountain, three miles in circumference and a quarter of a mile in perpendicular height, was thrown up in the courſe of one night.

3 Of the eruption in 1767.

The firſt great eruption taken notice of by Sir William Hamilton was that of 1767, which, though very violent, was mild in compariſon with that of 1538.

4 Nine eruptions from 1767 to 1779.

From this time (1767) Veſuvius never ceaſed for ten years to ſend forth ſmoke, nor were there many months in which it did not throw out ſtones, ſcoriæ, and cinders; which, increaſing to a certain degree, were uſually followed by lava; ſo that from the year 1767 to 1779 there were nine eruptions, ſome of them very conſiderable. In the month of Auguſt that year, however, an eruption took place, which, for its extraordinary and terrible appearance, may be reckoned among the moſt remarkable of any recorded concerning this or any other volcano.

5 Account of the great eruption in 1779.

During the whole month of July the mountain continued in a ſtate of fermentation. Subterraneous exploſions and rumbling noiſes were heard; quantities of ſmoke were thrown up with great violence, ſometimes with red-hot ſtones, ſcoriæ, and aſhes; and towards the end of the month theſe ſymptoms increaſed to ſuch a degree as to exhibit, in the night-time, the moſt beautiful fireworks that can be imagined.

On Thurſday 5th Auguſt the volcano appeared moſt violently agitated; a white and ſulphureous ſmoke iſſued continually and impetuouſly from its crater, one puff ſeeming to impel another; ſo that a maſs of them was ſoon accumulated, to appearance four times the height and ſize of the volcano itſelf. Theſe clouds of ſmoke were exceedingly white, ſo that the whole reſembled an immenſe accumulation of bales of the whiteſt cotton. In the midſt of this very white ſmoke, vaſt quantities of ſtones, ſcoriæ, and aſhes, were thrown up to the height of 2000 feet; and a quantity of liquid lava, ſeemingly very heavy, was lifted up juſt high enough to clear the rim of the crater, and take its way down the ſides of the mountains. This lava, having run violently for ſome hours, ſuddenly ceaſed, juſt before it had reached the cultivated parts of the mountain, near four miles from the ſpot whence it iſſued. The heat, all this day, was intolerable at the towns of Somma and Ottaiano; and was ſenſibly felt at Palma and Lauri, which are much farther off. Reddiſh aſhes fell ſo thick on the two former, that the air was darkened, and that objects could not be diſtinguiſhed at the diſtance of ten feet. Long filaments of a vitrified matter, like ſpun glaſs, were mixed, and fell with theſe aſhes; ſeveral birds in cages were ſuffocated, and the leaves of the trees in the neighbourhood of Somma were covered with white and very corroſive ſalt.

6 Extraordinary effuſion of fire by the approach of ſtormy clouds.

About 12 at night, on the 7th, the fermentation of the mountain ſeemed greatly to increaſe. Our author was watching the motions of the volcano from the mole at Naples, which has a full view of it. Several glorious picturesque effects had been obſerved from the reflection of the deep red fire within the crater of Veſuvius, and which mounted high amongſt thoſe huge clouds on the top of it: when a ſummer ſtorm, called in that country a *tropea*, came on ſuddenly, and blended its heavy watery clouds with the ſulphureous and mineral ones, which were already like ſo many other mountains piled up on the top of the volcano. At this moment a fountain of fire was ſhot up to an incredible height, caſting ſo bright a light, that the ſmalleſt objects were clearly diſtinguiſhable at any place within ſix miles or more of Veſuvius. The black ſtormy clouds, paſſing ſwiftly over, and at times covering the whole or a part of the bright column of fire, at other times clearing away and giving a full view of it, with the various tints produced by its reverberated light on the white clouds above in contraſt with the pale flaſhes of forked lightning that attended the tropea, formed ſuch a ſcene as no power of art can expreſs. One of his Sicilian majeſty's gamekeepers, who was out in the fields near Ottaiano whilſt this ſtorm was at its height, was ſurpriſed to find the drops of rain ſcald his face and hands; a phenomenon probably occaſioned by the clouds having acquired a great degree of heat in paſſing through the above-mentioned column of fire.

On the 8th, the mountain was quiet till towards ſix o'clock in the evening, when a great ſmoke began to gather over its crater; and about an hour after a rumbling

7
Immenſe fountain of lava thrown up by Veſuvius.

bling ſubterraneous noiſe was heard in the neighbourhood of the volcano; the uſual throws of red-hot ſtones and ſcoriæ began and increaſed every inſtant. The crater, viewed through a teleſcope, ſeemed much enlarged by the violence of laſt night's exploſions, and the little mountain on the top was entirely gone. About nine o'clock a moſt violent report was heard at Portici and its neighbourhood, which ſhook the houſes to ſuch a degree as made the inhabitants run out into the ſtreets. Many windows were broken, and walls cracked by the concuſſion of the air on this occaſion, though the noiſe was but faintly heard at Naples. In an inſtant a fountain of liquid tranſparent fire began to riſe, and gradually increaſing, arrived at laſt at the amazing height of ten thouſand feet and upwards. Puffs of ſmoke, as black as can poſſibly be imagined, ſucceeded one another haſtily, and accompanied the red-hot, tranſparent, and liquid lava, interrupting its ſplendid brightneſs here and there by patches of the darkeſt hue. Within theſe puffs of ſmoke, at the very moment of emiſſion, a bright but pale electrical fire was obſerved playing briſkly about in zig-zag lines. The wind was ſouth-weſt, and, though gentle, was ſufficient to carry theſe puffs of ſmoke out of the column of fire; and a collection of them by degrees formed a black and extenſive curtain behind it; in other parts of the ſky it was perfectly clear, and the ſtars bright. The fiery fountain, of ſuch immenſe magnitude, on the dark ground juſt mentioned, made the fineſt contraſt imaginable; and the blaze of it reflected from the ſurface of the ſea, which was at that time perfectly ſmooth, added greatly to this ſublime view.

The lava, mixed with ſtones and ſcoriæ, having riſen to the amazing height already mentioned, was partly directed by the wind towards Ottaiano, and partly falling, ſtill red hot and liquid, upon the top of Veſuvius, covered its whole cone, part of that of the ſummit of Somma, and the valley between them. The falling matter, being nearly as inflamed and vivid as that which was continually iſſuing freſh from the crater, formed with it one complete body of fire, which could not be leſs than two miles and a half in breadth, and of the extraordinary height above mentioned, and caſt a heat to the diſtance of at leaſt ſix miles round. The bruſhwood on the mountain of Somma was ſoon in a blaze, and the flame of it being of a different colour from the deep red of the matter thrown out by the volcano, and from the ſilvery blue of the electrical fire, ſtill added to the contraſt of this moſt extraordinary ſcene.

The black cloud, increaſing greatly, once bent towards Naples, and threatened the city with ſpeedy deſtruction; for it was charged with electrical fire, which kept conſtantly darting about in bright zig-zag lines. This fire, however, rarely quitted the cloud, but uſually returned to the great column of fire whence it proceeded; though once or twice it was ſeen to fall on the top of Somma, and ſet fire to ſome dry graſs and buſhes. Fortunately the wind carried back the cloud juſt as it reached the city, and had begun to occaſion great alarm. The column of fire, however, ſtill continued, and diffuſed ſuch a ſtrong light, that the moſt minute objects could be diſcerned at the diſtance of ten miles or more from the mountain. Mr Morris informed our author, that at Sorrento, which is 12 miles diſtant from Veſuvius, he read the title-page of a book by that volcanic light.

8
Diſtreſs of the inhabitants of Ottaiano.

All this time the miſerable inhabitants of Ottaiano were involved in the utmoſt diſtreſs and danger by the ſhowers of ſtones which fell upon them, and which, had the eruption continued for a longer time, would moſt certainly have reduced their town to the ſame ſituation with Herculaneum and Pompeii. The mountain of Somma, at the foot of which the town of Ottaiano is ſituated, hides Veſuvius from the view of its inhabitants; ſo that till the eruption became conſiderable it was not viſible to them. On Sunday night, when the noiſe increaſed, and the fire began to appear above the mountain of Somma, many of the inhabitants flew to the churches, and others were preparing to quit the town, when a ſudden and violent report was heard; ſoon after which they found themſelves involved in a thick cloud of ſmoke and aſhes; a horrid craſhing noiſe was heard in the air, and preſently fell a vaſt ſhower of ſtones and large pieces of ſcoriæ, ſome of which were of the diameter of ſeven or eight feet, which muſt have weighed more than 1000 pounds before they were broken, as ſome of the fragments which Sir William Hamilton found in the ſtreets ſtill weighed upwards of 60 pounds. When theſe large vitrified maſſes either ſtruck againſt one another in the air, or fell on the ground, they broke in many pieces, and covered a large ſpace of ground with vivid ſparks of fire, which communicated their heat to every thing that was combuſtible. Theſe maſſes were formed of the liquid lava; the exterior parts of which were become black and porous by cooling in their fall through ſuch a vaſt ſpace; whilſt the interior parts, leſs expoſed, retained an extreme heat, and were perfectly red.

In an inſtant the town and country about it was on fire in many parts, for there were ſeveral ſtraw huts in the vineyards, which had been erected for the watchmen of the grapes; all of which were burnt. A great magazine of wood in the heart of the town was all in a blaze; and had there been much wind, the flames muſt have ſpread univerſally, and all the inhabitants would have been burnt in their houſes; for it was impoſſible for them to ſtir out. Some, who attempted it with pillows, tables, chairs, the tops of wine caſks, &c. on their heads, were either knocked down or ſoon driven back to their cloſe quarters under arches and in the cellars of their houſes. Many were wounded, but only two perſons died of their wounds.

To add to the horror of the ſcene, inceſſant volcanic lightning was whiſking about the black cloud that ſurrounded them, and the ſulphureous ſmell and heat would ſcarcely allow them to draw their breath. In this dreadful ſituation they remained about 25 minutes, when the volcanic ſtorm ceaſed all at once, and Veſuvius remained ſullen and ſilent.

9
Vaſt quantity of electric matter in the air.

Some time after the eruption had ceaſed, the air continued greatly impregnated with electrical matter. The duke of Cottoſiano told our author, that having, about half an hour after the great eruption had ceaſed, held a Leyden bottle, armed with a pointed wire, out at his window at Naples, it ſoon became conſiderably charged. But whilſt the eruption was in force, its appearance was too alarming to allow one to think of ſuch experiments. —He was informed alſo by the prince of Monte Mileto, that

that his ſon, the duke of Popoli, who was at Monte Mileto the 8th of Auguſt, had been alarmed by the ſhower of cinders that fell there; ſome of which he had ſent to Naples weighing two ounces; and that ſtones of an ounce weight had fallen upon an eſtate of his ten miles farther off. Monte Mileto is about 30 miles from the volcano. The abbé Cagliani alſo related, that his ſiſter, a nun in a convent at Manfredonia, had written to inquire after him, imagining that Naples muſt have been deſtroyed, when they, at ſo great a diſtance, had been alarmed by a ſhower of aſhes which fell on the city at 11 o'clock at night, ſo much as to open all the churches, and go to prayers. As the great eruption happened at nine o'clock, theſe aſhes muſt have travelled 100 miles in the ſpace of two hours.

10 Damage done by the eruption at Ottaiano.

Nothing could be more diſmal than the appearance of Ottaiano after this eruption. The houſes were unroofed, half buried under the black ſcoriæ and aſhes; all the windows towards the mountain were broken, and ſome of the houſes themſelves burnt; the ſtreets choked up with aſhes, in ſome narrow places not leſs than four feet thick; and a few of the inhabitants who had juſt returned, were employed in clearing them away, and piling them up in hillocks, to get at their ruined houſes. The palace of the prince of Ottaiano is ſituated on an eminence above the town, and nearer the mountain. The ſteps leading up to it were deeply covered with volcanic matter; the roof was totally deſtroyed, and the windows broken, but the houſe itſelf, being ſtrongly built, had not ſuffered much.

11 Vaſt fragments of lava thrown out.

An incredible number of fragments of lava were thrown out during the eruption, ſome of which were of immenſe magnitude. The largeſt meaſured by Sir William Hamilton was 108 feet in circumference and 17 in height. This was thrown at leaſt a quarter of a mile clear of the mouth of the volcano. Another, 66 feet in circumference and 19 in height, being nearly of a ſpherical figure, was thrown out at the ſame time, and lay near the former. This laſt had the marks of being rounded, nay almoſt poliſhed, by continual rolling in torrents or on the ſea-ſhore. Our author conjectures that it might be a ſpherical volcanic ſalt, ſuch as that of 45 feet in circumference mentioned by M. de St Fond, in his Treatiſe of Extinguiſhed Volcanoes. A third of 16 feet in height and 92 in circumference was thrown much farther, and lay in the valley between Veſuvius and the Hermitage. It appeared alſo, from the large fragments that ſurrounded this maſs, that it had been much larger while in the air.

Veſuvius continued to emit ſmoke for a conſiderable time after this great eruption, ſo that our author was apprehenſive that another would ſoon enſue; but from that time nothing comparable to the above has taken place. From the time of this great eruption to the year 1784 our author kept an exact diary of the operations of Veſuvius, with drawings, ſhowing, by the quantity of ſmoke, the degree of fermentation within the volcano. The operations of the ſubterraneous fire, however, appear to be very capricious and uncertain. One day there is the appearance of a violent fermentation, and the next every thing is tranquil; but whenever there has been a conſiderable ejection of ſcoriæ and cinders, it has been a conſtant obſervation, that the lava ſoon made its appearance, either by boiling over the crater, or forcing its way through the crevices in the conical part of the mountain. An eruption took place in the month of November 1784, and continued for ſome time, but without any remarkable circumſtance.

VETCH. See VICIA, BOTANY *Index*.

VETERAN, among the ancient Romans, an appellation given to a *ſoldier* grown old in the ſervice, or who had made a certain number of campaigns.

VETERINARY ART. See FARRIERY.

VEXILLUM, in *Botany*; the upper petal of a pea-bloom, or butterfly-ſhaped flower, which is generally larger than any of the others.

VIALES, in mythology, a name given among the Romans to the gods who had the care and guard of the roads and highways.

VIATICUM, in Roman antiquity, an appellation given in common to all officers of any of the magiſtrates; as *lictors*, *accenſi*, *ſcribes*, *criers*.

VIBEX, is ſometimes uſed by phyſicians, for a black and blue ſpot in the ſkin occaſioned by an efflux or extravaſation of blood.

VIBRATION, in *Mechanics*, a regular, reciprocal motion of a body, as a pendulum.

VIBURNUM, a genus of plants of the claſs pentandria; and in the natural ſyſtem arranged under the 43d order, *Dumoſæ*. See BOTANY *Index*.

VICAR, a perſon appointed as deputy to another, to perform his functions in his abſence, and under his authority.

VICAR, in the canon-law, denotes a prieſt of a pariſh, the predial tithes whereof are impropriated or appropriated; that is, belong either to a chapter, religious houſe, &c. or to a layman who receives them, and only allows the vicar the ſmall tithes, or a convenient ſalary. See the article *PARSON and Vicar*.

VICE, in ethics, is ordinarily defined an elective habit, denoting either an exceſs or defect from the juſt medium wherein virtue is placed.

VICE, in ſmithery and other arts converſant in metals, a machine or inſtrument ſerving to hold faſt any thing they are at work upon, whether it is to be beaten, filed, or rivetted.

VICE is alſo uſed in the compoſition of divers words to denote the relation of ſomething that comes inſtead or in the place of another; as vice-admiral, vice-chancellor, &c. are officers who take place in the abſence of admirals, &c.

VICEROY, a governor of a kingdom, who commands in the name and inſtead of a king, with full and ſovereign authority.

VICIA, a genus of plants of the claſs diadelphia; and in the natural ſyſtem arranged under the 32d order, *Papilionaceæ*. See BOTANY *Index*.

VICISSITUDE, the regular ſucceſſion of one thing after another; as the viciſſitude of day and night, of the ſeaſons, &c.

VICTIM, denotes a ſacrifice offered to ſome deity, of a living creature, as a man or beaſt, which is ſlain to appeaſe his wrath, or to obtain ſome favour.

VICTOR, SEXTUS AURELIUS, a Roman hiſtorian, who flouriſhed under the emperors Conſtantius and Julian; as we learn from many paſſages in his own writings, and alſo from Ammianus Marcellinus. This hiſtorian relates, that Conſtantius made him conſul, and honoured him with a brazen ſtatue, on account of his excellent qualifications; although, as he owns of himſelf, he was born in an obſcure village, and of poor and illiterate parents. It is commonly believed that he was an African: it is certain, that he dwells much upon the praiſes of that country, which he calls the glory of the earth; *decus terrarum.* Two books of his are extant in the hiſtorical way: one *De viris illuſtribus urbis Romæ;* the other, *De Cæſaribus;* to which is prefixed *Libellus de origine gentis Romanæ.* The whole makes an abridged hiſtory of Rome, from its foundation down to the reign of Julian incluſive.

VICTORY, the overthrow or defeat of an enemy in war or combat.

VICTORY, in Pagan worſhip, is repreſented by Heſiod as the daughter of Styx and Pallas; and Varro calls her the *daughter of Heaven and Earth.* The Romans erected a temple to her, where they prayed to the gods to give ſucceſs to their arms. They painted her in the form of a woman, clad in cloth of gold. In ſome medals, ſhe is repreſented with wings flying through the air, holding a laurel crown in one hand and a palm in the other; but in other medals, ſhe is ſeen ſtanding upon a globe, with the ſame crown and branch of palm.

VIDA, MARCUS HIERONYMUS, biſhop of Alva, in Montſerrat, and one of the moſt excellent Latin poets that have appeared ſince the Auguſtan age, was born at Cremona in 1470. Having diſtinguiſhed himſelf by his learning and taſte for literature, he was made biſhop of Alva in 1552. After continuing two years with Pope Clement VII. at Rome, he went to reſide upon his ſee; where, for 30 years, he performed all the offices of a good biſhop and a good man; and though he was mild, gentle, and full of goodneſs, he was ſo far from wanting ſpirit, that when the city of Alva was beſieged by the French, he uſed all poſſible means to prevent its being given up, by ſtrenuouſly exhorting the people, and, when proviſions were ſcarce, by ſupplying them at his own expence. His Poetics, and poem on the ſilkworm, paſs for his maſterpiece; his poem on the game of cheſs is alſo greatly admired. He alſo wrote hymns, eclogues, and a poem entitled *Chriſtiados* in ſix books; all which are in Latin, and have gained him a great reputation. His works in proſe conſiſt of dialogues, ſynodical conſtitutions, letters, and other pieces. He died in 1566, ſoon after being made biſhop of Cremona.

VIENNA, the capital of the circle of Auſtria, in Germany, and of the whole German empire, is the place where the emperor reſides. The city itſelf is not of very great extent; nor can it be enlarged, it being limited by a very ſtrong fortification; but it is very populous. The ſtreets, in general, are narrow, and the houſes built high. Some of the public buildings are magnificent; but they appear externally to no great advantage, on account of the narrowneſs of the ſtreets. The chief of them are the imperial palace, the library, and the muſeum; the palaces of the princes Lichtenſtein, Eugene, &c. Vienna was twice ineffectually beſieged by the Turks; namely, in 1589 and 1683. At the latter period, the ſiege was raiſed by John Sobieſki, king of Poland, who totally defeated the Turkiſh army before the walls of this place. There is no great danger that Vienna will ever again be ſubjected to the inconveniences of a ſiege. Yet, in caſe that ſhould happen, a meaſure has been taken, which will prevent the neceſſity of deſtroying the ſuburbs; namely, no houſes without the walls are allowed to be built nearer to the glacis than 600 yards; ſo that there is a circular field of that breadth all round the town, which, excluſive of the advantage above-mentioned, has a very beautiful and ſalutary effect. Theſe magnificent ſuburbs, and the town together, are ſaid to contain above 300,000 inhabitants; yet the former are not near ſo populous, in proportion to their ſize, as the town; becauſe many houſes in the ſuburbs have extenſive gardens belonging to them, and many families, who live during the winter within the fortifications, ſpend the ſummer in the ſuburbs. The cathedral is built of free-ſtone, is 114 yards long, and 48 broad, and the ſteeple is 447 feet high. Inſtead of a weather-cock there was a Turkiſh creſcent, in memory of the ſiege in 1589; but, after the ſecond ſiege in 1683, it was changed for a golden croſs, which three months after was thrown down by a ſtorm. At preſent there is a black ſpread eagle, over which is a gilded croſs. Joining to this church is the archbiſhop's palace, the front of which is very fine. The univerſity had ſeveral thouſand ſtudents, who, when this city was beſieged, mounted guard, as they did alſo in 1741. Beſide this, there is the academy of Lower Auſtria; and the archducal library is much frequented by foreigners, as it contains above 100,000 printed books, and 10,000 manuſcripts. The academy of painting is remarkable for the fine pictures it produces. The archducal treaſury, and a cabinet of curioſities of the houſe of Auſtria, are great rarities. The inhabitants, in general, live in a ſplendid manner; and people of diſtinction have all ſorts of wines at their tables, which they are very free with to foreigners. There is a ſort of harbour on the Danube, where there are magazines of naval ſtores, and ſhips have been fitted out to ſerve on that river againſt the Turks. Vienna is an archbiſhop's ſee. It is ſeated at the place where the river Vienna or Wein, falls into the Danube, 30 miles weſt of Preſburgh, 350 north-north-eaſt of Rome, 520 ſouth-eaſt by ſouth of Amſterdam, 565 eaſt of Paris, and 680 eaſt-ſouth eaſt of London. E. Long. 16. 28. N. Lat. 48. 13.

VIGIL, in church hiſtory, is the eve or next day bebefore any ſolemn feaſt; becauſe then Chriſtians were wont to watch, faſt, and pray, in their churches.

VIGILS of Plants, a term under which botaniſts comprehend the preciſe time of the day in which the flowers of different plants open, expand, and ſhut.

As all plants do not flower in the ſame ſeaſon, or month; in like manner, thoſe which flower the ſame day, in the ſame place, do not open and ſhut preciſely at the ſame hour. Some open in the morning, as the lip flowers, and compound flowers with flat ſpreading petals; others at noon, as the mallows; and a third ſet in the evening, or after ſunſet, as ſome geraniums and opuntias: the hour of ſhutting is equally determined. Of thoſe which open in the morning, ſome ſhut ſoon after, while others remain expanded till night.

The hours of opening, like the time of flowering, ſeem to vary, according to the ſpecies of the plant, the temperature of the climate, and that of the ſeaſon. Flowers, whoſe extreme delicacy would be hurt by the ſtrong impreſſions of an ardent ſun, do not open till night; thoſe which require a moderate degree of heat to elevate their juices; in other words, whoſe juices do not riſe but in the morning or evening, do not expand till then; whilſt thoſe which need a more lively heat for the ſame purpoſe, expand at noon, when the ſun is in his meridian ſtrength. Hence it is, that the heat of the air being greater betwixt the tropics than elſewhere, plants which are tranſported from thoſe climates into the cold or temperate climates of Europe, expand their flowers much later than in their native ſoil. Thus, a flower which opens in ſummer at ſix o'clock in the morning at Senegal, will not open at the ſame ſeaſon in France and England till eight or nine, nor in Sweden till ten.

Linnæus diſtinguiſhes by the general name of *ſolar* (*flores ſolares*) all thoſe flowers which obſerve a determinate time in opening and ſhutting. Theſe flowers are again divided, from certain circumſtances, into three ſpecies, or kinds:

Equinoctial flowers (*flores æquinoctiales*) are ſuch as open and ſhut at all ſeaſons, at a certain fixed or determinate hour.

Tropical flowers (*flores tropici*) are ſuch whoſe hour of opening is not fixed at all ſeaſons, but accelerated or retarded according as the length of the day is increaſed or diminiſhed.

Meteorous flowers (*flores meteorici*) are ſuch whoſe hour of expanſion depends upon the dry or humid ſtate of the air, and the greater or leſs preſſure of the atmoſphere. Of this kind is the Siberian ſow-thiſtle, which ſhuts at night if the enſuing day is to be clear and ſerene, and opens if it is to be cloudy and rainy. In like manner the African marigold, which in dry ſerene weather opens at ſix or ſeven in the morning, and ſhuts at four o'clock in the afternoon, is a ſure indication that rain will fall during the courſe of the day, when it continues ſhut after ſeven.

VIGO, a ſea port town of Galicia in Spain, with an old caſtle and a fort. It is ſeated in a fertile country by the ſea-ſide. It was rendered famous by a ſea-fight between the confederate fleet commanded by Sir George Rook, and a ſquadron of French men of war, while the duke of Ormond with a body of land forces drove the Spaniards from the caſtles which defended the harbour. Admiral Hopſon having with infinite danger broken through the boom made acroſs the mouth of the harbour, the Engliſh took four galleons and five large men of war, and the Dutch five galleons and one man of war. Four galleons, with 14 men of war, were deſtroyed, with abundance of plate and other rich effects. W. Long. 8. 21. N. Lat. 42. 3.

VILLA FRANCA, the name of ſeveral towns; one in Piedmont, three miles eaſt of Nice; another of Catalonia, 18 miles weſt of Barcelona; a third, the capital of St Michael, one of the Azores; and a fourth, a town of Eſtremadura in Spain, 57 miles ſouth-eaſt of Salamanca.

VILLAGE, an aſſemblage of houſes inhabited chiefly by peaſants and farmers, and having no market, whereby it is diſtinguiſhed from a town. The word is French, formed of *vil* or *vilis*, "low, mean, contemptible:" or rather, from the Latin *villa*, a country-houſe or farm.

VILLAIN, or VILLEIN, in our ancient cuſtoms, denotes a man of ſervile or baſe condition, viz. a bondman or ſervant.

VILLENAGE, in *Law*. The folk-land or eſtates held in villenage, was a ſpecies of tenure neither ſtrictly feodal, Norman, or Saxon; but mixed and compounded of them all; and which alſo, on account of the heriots that uſually attend it, may ſeem to have ſomewhat Daniſh in its compoſition. Under the Saxon government there were, as Sir William Temple ſpeaks, a ſort of people in a condition of downright ſervitude, uſed and employed in the moſt ſervile works, and belonging, both they, their children, and effects, to the lord of the ſoil, like the reſt of the cattle or ſtock upon it. Theſe ſeem to have been thoſe who held what was called the *folk-land*, from which they were removeable at the lord's pleaſure. On the arrival of the Normans here, it ſeems not improbable, that they, who were ſtrangers to any other than a feodal ſtate, might give ſome ſparks of enfranchiſement to ſuch wretched perſons as fell to their ſhare, by admitting them, as well as others, to the oath of fealty; which conferred a right of protection, and raiſed the tenant to a kind of eſtate ſuperior to downright ſlavery, but inferior to every other condition. This they called *villenage*, and the tenants *villeins*.

Theſe villeins, belonging principally to lords of manors, were either villeins *regardant*, that is, annexed to the manor or land: or elſe they were *in groſs*, or at large, that is, annexed to the perſon of the lord, and transferable by deed from one owner to another. They could not leave their lord without his permiſſion; but, if they ran away, or were purloined from him, might be claimed and recovered by action, like beaſts or other chattels. They held indeed ſmall portions of land by way of ſuſtaining themſelves and families: but it was at the mere will of the lord, who might diſpoſſeſs them whenever he pleaſed; and it was upon villein ſervices, that is, to carry out dung, to hedge and ditch the lord's demeſnes, and any other the meaneſt offices: and their ſervices were not only baſe, but uncertain both as to their time and quantity.

A villein could acquire no property either in lands or goods: if he purchaſed either, the lord might ſeize them to his own uſe; unleſs he contrived to diſpoſe of them again before the lord had ſeized them, for the lord had then loſt his opportunity.

In many places alſo a fine was payable to the lord, if the villein preſumed to marry his daughter to any one with leave from the lord: and, by the common law, the lord might alſo bring an action againſt the huſband for damages in thus purloining his property. For the children of villeins were alſo in the ſame ſtate of bondage with their parents; whence they were called in Latin *nativi*, which gave riſe to the female appellation of a villein, who was called a *neiſe*. In caſe of a marriage between a freeman and a neiſe, or a villein and a freewoman, the iſſue followed the condition of the father, being free if he was free, and a villein if he was villein, contrary to the maxim of the civil law, that *partus ſequitur ventrem*. But no baſtard could be born a villein, becauſe by another maxim of our law he is *nullius filius*; and as he can *gain* nothing by inheritance, it were hard that he ſhould *loſe* his natural freedom by it. The law, however, protected the perſons of villeins againſt atrocious injuries of the lord: for he might not kill or maim his villein; though he might beat him with impunity.

Villeins might be enfranchiſed by manumiſſion. In proceſs of time they gained conſiderable ground on their lords; and in particular ſtrengthened the tenure of their eſtates to that degree, that they came to have in them an intereſt in many places full as good, in others better than

than their lords. For the good nature and benevolence of many lords of manors having, time out of mind, permitted their villeins and their children to enjoy their poſſeſſions without interruption, in a regular courſe of deſcent, the common law, of which cuſtom is the life, now gave them title to preſcribe againſt their lords; and, on performance of the ſame ſervices, to hold their lands, in ſpite of any determination of the lord's will. For though in general they are ſtill ſaid to hold their eſtates at the will of the lord, yet it is ſuch a will as is agreeable to the cuſtom of the manor; which cuſtoms are preſerved and evidenced by the rolls of the ſeveral courts-baron in which they are entered, or kept on foot by the conſtant immemorial uſage of the ſeveral manors in which the lands lie. And as ſuch tenants had nothing to ſhow for their eſtates but thoſe cuſtoms, and admiſſions in purſuance of them, entered on theſe rolls, or the copies of ſuch entries witneſſed by the ſteward, they now began to be called *tenants by copy of court-roll*, and their tenure itſelf a *copyhold*.

Privileged VILLENAGE, a ſpecies of tenure otherwiſe called *villein-ſocage*. See TENURE.

Ancient demeſne conſiſts of thoſe lands or manors which, though now perhaps granted out to private ſubjects, were actually in the hands of the crown in the time of Edward the Confeſſor, or William the Conqueror; and ſo appear to have been, by the great ſurvey in the exchequer, called the *doomſday-book*. The tenants of theſe lands, under the crown, were not all of the ſame order or degree. Some of them, as Britton teſtifies, continued for a long time pure and abſolute villeins, dependent on the will of the lord; and common copyholders in only a few points. Others were in a great meaſure enfranchiſed by the royal favour; being only bound in reſpect of their lands to perform ſome of the better ſort of villein-ſervices, but thoſe determinate and certain; as, to plough the king's land for ſo many days, to ſupply his court with ſuch a quantity of proviſions, and the like; all of which are now changed into pecuniary rents: and in conſideration hereof they had many immunities and privileges granted to them; as, to try the right of their property in a peculiar court of their own, called a *court of ancient demeſne*, by a peculiar proceſs denominated a writ of right cloſe; not to pay toll or taxes; not to contribute to the expences of knights of the ſhire; not to be put on juries, and the like.

Theſe tenants therefore, though their tenure be abſolutely copyhold, yet have an intereſt equivalent to a freehold: for though their ſervices were of a baſe and and villenous original, yet the tenants were eſteemed in all others reſpects to be highly privileged villeins; and eſpecially for that their ſervices were fixed and determinate, and that they could not be compelled (like pure villeins) to relinquiſh thoſe tenements at the lords's will, or to hold them againſt their own: *et ideo* (ſays Bracton) *dicuntur liberi*.

Lands holding by this tenure are therefore a ſpecies of copyhold, and as ſuch preſerved and exempted from the operation of the ſtatute of Charles II. Yet they differ from common copyholds, principally in the privileges before mentioned: as alſo they differ from freeholders by one eſpecial mark and tincture of villenage, noted by Bracton, and remaining to this day; viz. that they cannot be conveyed from man to man by the general common-law conveyances of feoffment, and the reſt; but muſt paſs by ſurrender to the lord or his ſteward, in the manner of common copyholds: yet with the difference, that, in the ſurrenders of theſe lands in ancient demeſne, it is not uſed to ſay, "to hold at the will of their lord," in their copies; but only, "to hold according to the cuſtom of the manor."

VILLI, among botaniſts, a kind of down like ſhort hair, with which ſome trees abound.

VILLOSE, or VILLOUS, ſomething abounding with villi or fibres like ſhort hair; ſuch is one of the coats of the ſtomach.

VINCA, a genus of plants of the claſs pentandria; and in the natural ſyſtem arranged under the 30th order, *Contortæ*. See BOTANY *Index*.

ST VINCENT, one of the windward Caribbee iſlands, which received its name from being diſcovered on the 22d of January, the feaſt of that Saint. It is inhabited by a race of people, of whom Dr Robertſon gives this account: "There is a great diſtinction in character between the Caribbees and the inhabitants of the larger iſlands. The former appear manifeſtly to be a ſeparate race. Their language is totally different from that of their neighbours in the large iſlands. They themſelves have a tradition that their anceſtors came originally from ſome part of the continent, and having conquered and exterminated the ancient inhabitants, took poſſeſſion of their lands and of their women. Hence they call themſelves Banaree, which ſignifies a man come from beyond ſea. Accordingly, the Caribbees ſtill uſe two diſtinct languages, one peculiar to the men, and the other to the women. The language of the men has nothing common with that ſpoken in the large iſlands. The dialect of the women conſiderably reſembles it. This ſtrongly confirms the tradition which I have mentioned. The Caribbees themſelves imagine that they were a colony from the Galibis, a powerful nation of Guiana in South America. But as their fierce manners approach nearer to thoſe of the people in the northern continent, than to thoſe of the natives of South America, and as their language has likewiſe ſome affinity to that ſpoken in Florida, their origin ſhould be deduced rather from the former than from the latter. In their wars they ſtill preſerve their ancient practice of deſtroying all the males, and preſerving the women either for ſervitude or for breeding."

It remained a long time after it was diſcovered inhabited by theſe people, and by another race improperly ſtyled *Black Caribs*, who are in reality negroes deſcended, as is generally believed, from ſome who eſcaped out of a Guinea ſhip wrecked upon the coaſt, and gradually augmented by ſuch as from time to time fled thither from Barbadoes. Theſe nations were often at war; but when their quarrels were compoſed, they had a ſtrength ſufficient to prevent ſtrangers from ſettling by force. The French, about half a century ago, at the requeſt of the Caribs, made a deſcent from Martinico, and attacked the negroes, but were repulſed with loſs; and found it their intereſt to conciliate a friendſhip with both nations by means of preſents, and furniſhing them with arms and ammunition.

St Vincent was long a neutral iſland; but, at the peace of 1763, the French agreed that the right to it ſhould be veſted in the Engliſh; who, in the ſequel, at the inſtance of ſome rapacious planters, engaged in an unjuſt war againſt the Caribbees, who inhabited the windward ſide of the iſland, and who were obliged to conſent to a peace, by which they ceded a very large tract of valuable land to the crown. The conſequence of this was, that in the next war, in 1779, they greatly contributed to the reduction of this iſland by the French, who, however, reſtored it by the peace of 1783. Since that time it has continued in the poſſeſſion of Great Britain. During the French revolutionary war, the Caribs revolted; and, aſſiſted by the French, ſpread deſolation over the whole iſland; but by the exertions of the governor and the Britiſh forces in the Weſt Indies, the revolt was quelled.

St Vincent is in length about 24 miles, and about 18 in breadth. The climate is very warm. The country is in generally hilly, in ſome places mountainous; but interſperſed with a variety of pleaſant valleys, and ſome luxuriant plains, the ſoil being everywhere very fertile, and the high grounds are at leaſt in general eaſy of aſcent. Few iſlands are ſo well watered with rivers and ſprings. The inhabitants raiſe all kinds of ground proviſions in plenty. The rivers ſupply them with variety of fiſh. W. Long, 61°. N. Lat. 13°.

VINCI, LEONARDO DA, an illuſtrious Italian painter, deſcended from a noble Tuſcan family, was born in the caſtle of Vinci, near Florence in 1445. He was placed under Andrea Verochia, a celebrated painter in that city; but ſoon ſurpaſſed him and all his predeceſſors ſo much, as to be reputed the maſter of the third or golden age of modern painting. But his ſtudies were far from terminating here; no man's genius was more univerſal: he applied himſelf to arts, to literature, and to the accompliſhments of the body; and he excelled in every thing which he attempted. Lewis Sforza duke of Milan prevailed on him to be director of the academy for architecture he had juſt eſtabliſhed; where Leonardo ſoon baniſhed all the Gothic faſhions, and reduced every thing to the happy ſimplicity of the Greek and Roman ſtyle. By the duke's order he conſtructed the famous aqueduct that ſupplies the city of Milan with water: this canal goes by the name of *Morteſana*, being above 200 miles in length, and conducts the water of the river Adda quite to the walls of the city. In 1479, he was deſired to conſtruct ſome new device for the entertainment of Louis XII. of France, who was then to make his entrance into Milan. Leonardo accordingly made a very curious automaton in the form of a lion, which marched out to meet the king, reared up on its hinder legs before him, and opening its breaſt, diſplayed an eſcutcheon with fleurs de lys quartered on it. The diſorders of Lombardy, with the misfortunes of his patrons the Sforzi, obliging Leonardo to quit Milan, he retired to Florence, where he flouriſhed under the Medici: here he raiſed the envy of Michael Angelo, who was his contemporary; and Raphael, from the ſtudy of his works, acquired his beſt manner of deſigning. At length, on the invitation of Francis I. he removed to France when above 70 years of age; where the journey and change of climate threw him into his laſt ſickneſs: he languiſhed for ſome months at Fontainbleau, where the king came frequently to ſee him; and one day riſing up in his bed to acknowledge the honour done him, he fainted, and Francis ſupporting him, Leonardo died in his arms. His death happened in 1520. Some of his paintings are to be ſeen in England and other countries, but the greateſt part of them are in Florence and France. He compoſed a great number of diſcourſes on curious ſubjects; but none of them have been publiſhed but his treatiſe on the Art of Painting.—For his anatomical knowledge, ſee ANATOMY (hiſtory of), p. 669.

VINCULUM, in *Algebra*, a character in form of a line or ſtroke drawn over a factor, diviſor, or dividend, when compounded of ſeveral letters or quantities to connect them, and ſhows that they are to be multiplied or divided, &c. together by the other term.

Thus $d \times \overline{a+b-c}$ ſhows that d is to be multiplied into $a+b-c$.

VINE. See VITIS, BOTANY *Index*.

VINEGAR, ACETUM, an agreeable acid, prepared from wine, cyder, beer, and other liquors; of conſiderable uſe, both as a medicine and a ſauce. The word is French, *vinaigre;* formed from *vin*, "wine;" and *aigre*, "ſour." See ACETIC *Acid*, and CHEMISTRY *Index*.

Eels in VINEGAR. See ANIMALCULE, n° 9.

VINEYARD, a plantation of vines. The beſt ſituation of a vineyard is on the declivity of a hill facing the ſouth.

VIO, THOMAS DE. See CAJETAN.

VIOL, a muſical inſtrument of the ſame form with the violin, and, like that, ſtruck with a bow.

VIOLA, a genus of plants of the claſs *ſyngeneſia;* in the natural ſyſtem arranged under the 29th order, *Campanaceæ*. See BOTANY *Index*.

VIOLATION, the act of violating, that is, forcing a woman, or committing a rape upon her.—This term is alſo uſed in a moral ſenſe, for a breach or infringement of a law, ordinance, or the like.

VIOLET. See VIOLA, BOTANY *Index*.

VIOLET-Crab. See CANCER, ENTOMOLOGY *Index*.

VIOLIN, or FIDDLE, a muſical inſtrument mounted with four ſtrings or guts, and ſtruck or played with a bow. The ſtyle and ſound of the violin is the gayeſt and moſt ſprightly of all other inſtruments; and hence it is of all others the fitteſt for dancing. Yet there are ways of touching it, which render it grave, ſoft, languiſhing, and fit for church or chamber muſic.—It generally makes the treble or higheſt parts in concerts. Its harmony is from fifth to fifth. Its play is compoſed of baſs, counter-tenor, tenor, and treble; to which may be added, a fifth part: each part has four fifths, which riſe to a greater ſeventeenth.

VIOLONCELLO, of the Italians, is properly our fifth violin; which is a little baſs violin half the ſize of the common baſs violin, and the ſtrings bigger and longer in proportion: conſequently its ſound is an octave lower than our baſs violin; which has a noble effect in concerts.

VIPER. See OPHIOLOGY *Index*.

VIRAGO, a woman of extraordinary ſtature and courage; who has the mein and air of a man, and performs the actions and exerciſes of men.

VIRGIL, or PUBLIUS VIRGILIUS MARO, the moſt excellent of all the Latin poets, was the ſon of a potter of Andes, near Mantua, where he was born, 70 years B. C. He ſtudied firſt at Mantua; then at Cremona, Milan, and Naples; whence going to Rome, he acquired the eſteem of the greateſt wits and moſt illuſtrious perſons of his time; and among others of the emperor Auguſtus, Mæcenas, and Pollio. He was well ſkilled not only in polite literature and poetry, but alſo in philoſophy, the

the mathematics, geography, medicine, and natural hiſtory. Though one of the greateſt geniuſes of his age, and the admiration of the Romans, he always preſerved a ſingular modeſty, and lived chaſte at a time when the manners of the people were extremely corrupt. He carried Latin poetry to ſuch an high perfection, that he was juſtly eſteemed the prince of Latin poets. He firſt turned himſelf to paſtoral; and being captivated with the beauty and ſweetneſs of Theocritus, was ambitious to introduce this new ſpecies of poetry among the Romans. His firſt performance in this way is ſuppoſed to have been written U. C. 907, the year before the death of Julius Cæſar, when the poet was in his 25th year: it is intitled *Alexis*. Poſſibly *Palæmon* was his ſecond: it is a cloſe imitation of the fourth and fifth Idylls of Theocritus. Mr Wharton places *Silenus* next; which is ſaid to have been publicly recited on the ſtage by Cytheris, a celebrated comedian. Virgil's fifth eclogue is compoſed in alluſion to the death and deification of Cæſar. The battle of Philippi in 712 having put an end to the Roman liberty, the veteran ſoldiers began to murmur for their pay; and Auguſtus, to reward them, diſtributed among them the lands of Mantua and Cremona. Virgil was involved in this common calamity; and applied to Varus and Pollio, who warmly recommended him to Auguſtus, and procured for him his patrimony again. Full of gratitude to Auguſtus, he compoſed the *Tityrus*, in which he introduces two ſhepherds; one of them complaining of the diſtraction of the times, and of the havock the ſoldiers made among the Mantuan farmers; the other rejoicing for the recovery of his eſtate, and promiſing to honour as a god the perſon who reſtored it to him. But our poet's joy was not of long continuance; for we are told, that when he returned to take poſſeſſion of his farm, he was violently aſſaulted by the intruder, and would certainly have been killed by him if he had not eſcaped by ſwimming haſtily over the Mincio. Upon this unexpected diſappointment, he returned to Rome to renew his petition; and during his journey ſeems to have compoſed his ninth eclogue. The celebrated eclogue, intitled *Pollio*, was compoſed U. C. 714, upon the following occaſion: The conſul Pollio on the part of Antony, and Mæcenas on the part of Cæſar, had made up the differences between them; by agreeing, that Octavia, half-ſiſter to Cæſar, ſhould be given in marriage to Antony. This agreement cauſed an univerſal joy; and Virgil, in his eclogue, teſtified his. Octavia was with child by her late huſband Marcellus at the time of this marriage; and whereas the Sibylline oracles had foretold, that a child was to be born about this time, who ſhould rule the world, and eſtabliſh perpetual peace, the poet ingeniouſly ſuppoſes the child in Octavia's womb to be the glorious infant, under whoſe reign mankind was to be happy, the golden age to return from heaven, and fraud and violence to be no more. In this celebrated poem, the author, with great delicacy at the ſame time, pays his court to both the chiefs, to his patron Pollio, to Octavia, and to the unborn infant. In 715, Pollio was ſent againſt the Parthini, a people of Illyricum; and during this expedition, Virgil addreſſed to him a beautiful eclogue, called *Pharmaceutria*. His tenth and laſt eclogue was addreſſed to Gallus.

In his 34th year, he retired to Naples, and laid the plan of his Georgics; which he undertook at the intreaties of Mæcenas, to whom he dedicated them. This wiſe and able miniſter reſolved, if poſſible, to revive the decayed ſpirit of huſbandry; to introduce a taſte for agriculture, even among the great; and could not think of a better method to effect this, than to recommend it by the inſinuating charms of poetry. Virgil fully anſwered the expectations of his patron by his Georgics. They are divided into four books. Corn and ploughing are the ſubject of the firſt, vines of the ſecond, cattle of the third, and bees of the fourth.

He is ſuppoſed to have been in his 45th year when he began to write the Æneid; the deſign of which was to reconcile the Romans to the government of Auguſtus. Auguſtus was eager to peruſe this poem before it was finiſhed; and intreated him by letters to communicate it. Macrobius has preſerved to us part of one of Virgil's anſwers to the emperor, in which the poet excuſes himſelf: who, however, at length complied, and read himſelf the ſixth book to the emperor; when Octavia, who had juſt loſt her ſon Marcellus, the darling of Rome, and adopted ſon of Auguſtus, made one of the audience. Virgil had artfully inſerted that beautiful lamentation for the death of young Marcellus, beginning with—*O nate, ingentem luctum ne quære tuorum*—but ſuppreſſed his name till he came to the line—*Tu Marcellus eris*: upon hearing which, Octavia could bear no more, but fainted away, overcome with ſurpriſe and ſorrow. When ſhe recovered, ſhe made the poet a preſent of ten ſeſterces for every line, which amounted in the whole to above 2000l.

The Æneid being brought to a concluſion, but not to the perfection our author intended to give it, he reſolved to travel into Greece, to correct and poliſh it at leiſure. It was probably on this occaſion that Horace addreſſed that affectionate ode to him, *Sic te Divæ potens Cypri, &c.* Auguſtus returning victorious from the eaſt, met with Virgil at Athens, who thought himſelf obliged to attend the emperor to Italy: but the poet was ſuddenly ſeized with a fatal diſtemper, which being increaſed by the agitation of the veſſel, put an end to his life as ſoon as he landed at Brunduſium, in his 52d year. He had ordered in his will, that the Æneid ſhould be burnt as an unfiniſhed poem; but Auguſtus forbade it, and had it delivered to Varius and Tucca, with the ſtricteſt charge to make no additions, but only to publiſh it correctly. He died with ſuch ſteadineſs and tranquillity, as to be able to dictate his own epitaph in the following words:

Mantua me genuit: Calabri rapuere, tenet nunc
Parthenope: cecini Paſcua, Rura, Duces.

His bones were carried to Naples, according to his earneſt requeſt; and a monument was erected at a ſmall diſtance from the city.

Virgil was of a ſwarthy complexion, tall, of a ſickly conſtitution, and afflicted with frequent headachs and ſpitting of blood. He was ſo very baſhful, that he often ran into the ſhops to prevent being gazed at in the ſtreets; yet was ſo honoured by the Roman people, that once coming into the theatre, the whole audience roſe up out of reſpect to him. He was of a thoughtful and melancholy temper; he ſpoke little, and loved retirement and contemplation. His fortune was affluent; he had a fine houſe and well furniſhed library near Mæcenas's gardens, on the Eſquiline mount at Rome, and alſo a delightful villa in Sicily. He was ſo benevolent and inoffenſive, that moſt of his contemporary poets, though they envied each other, agreed in loving and eſteeming him. He reviſed his verſes with prodigious ſeverity; and uſed to compare himſelf to a ſhe bear, which licked her cubs into ſhape.

The beſt edition of Virgil's works are thoſe of Moſvicius, with the notes of Servius, printed at Lewarden in 1717, two vols 4to; and that of Burman, at Amſterdam, 1746, in four vols 4to. There are ſeveral Engliſh tranſlations, which are well known.

VIRGIL, *Polydore*, an Engliſh hiſtorian, born at Urbino in Italy, was ſent in the beginning of the 16th century, by Pope Alexander VI. as ſub-collector of the Papal tax, called *Peter-pence*, in this kingdom. He had not been long in England before he obtained preferment in the church; for in 1503 he was preſented to the rectory of Church-Langton in the archdeaconry of Leiceſter. In 1507 he was collated to the prebend of Scamleſby in the church of Lincoln; and in the ſame year was made archdeacon of Wells, and prebendary of Hereford. In 1513, he reſigned his prebend of Lincoln, and was collated to that of Oxgate in St Paul's, London. We are told, that on his preferment to the archdeaconry of Wells, he reſigned the office of ſubcollector to the pope, and determined to ſpend the remainder of his life in England, the Hiſtory of which kingdom he began in the year 1505, at the command of Henry VII. That work coſt him 12 years labour. In 1526, he finiſhed his treatiſe on Prodigies. Polydore continued in England during the whole reign of Henry VIII. and part of that of Edward VI. whence it is concluded that he was a moderate Papiſt. In 1550, being now an old man, he requeſted leave to reviſit his native country. He was accordingly diſmiſſed with a preſent of 300 crowns, together with the privilege of holding his preferments to the end of his life. He died at Urbino in the year 1555. As an hiſtorian, he is accuſed by ſome as a malignant ſlanderer of the Engliſh nation; yet Jovius remarks, that the French and Scotch accuſe him of having flattered that nation too much: (See his *Elog.* cap. 135. p. 179.). Beſides the above, he wrote, 1. *De Rerum Inventoribus*; of which an Engliſh tranſlation was publiſhed by Langley in 1663. It was alſo tranſlated into French and Spaniſh. 2. *De Prodigiis et Sortibus.* 3. *Epiſcoporum Angliæ Catalogus.* Manuſcript. 4. *De Vita Perfecta*, Baſil, 1546, 1553, 8vo. 5. *Epiſtolæ Eruditæ*; and ſome other works.

VIRGINIA, one of the United States of North America, is bounded on the eaſt by the Atlantic ocean, on the north by Pennſylvania and the river Ohio, on the weſt by the Miſſiſſippi, on the ſouth by North Carolina.

Theſe boundaries include an area ſomewhat triangular of 121,525 miles, whereof 79,650 lie weſtward of the Alleghany mountains, and 57,034 weſtward of the meridian of the mouth of the Great Kanhaway. This ſtate is therefore one third larger than the iſlands of Great Britain and Ireland, which are reckoned at 88,357 ſquare miles.

The principal rivers in Virginia are, Roanoke, James river, which receives the Rivanna, Appammatox, Chickahominy, Nanſemond, and Elizabeth rivers; York river, which is formed by the junction of Pamunky and Mattapony rivers; Rappahannock, and Patomack.

The mountains are not ſolitary and ſcattered confuſedly over the face of the country; they commence at about 150 miles from the ſea coaſt, and are diſpoſed in ridges one behind another, running nearly parallel with the coaſt, though rather approaching it as they advance north-eaſtwardly. To the ſouth-weſt, as the tract of country between the ſea-coaſt and the Miſſiſſipi becomes narrower, the mountains converge into a ſingle ridge, which, as it approaches the gulf of Mexico, ſubſides into plain country, and gives riſe to ſome of the waters of that gulf.

Jefferſon's Virginia.

From the great extent of Virginia, it may be expected that the climate is not the ſame in all its parts. It is remarkable that, proceeding on the ſame parallel of latitude weſtwardly, the climate becomes colder in like manner as when you proceed northwardly. This continues to be the caſe till you attain the ſummit of the Alleghany, which is the higheſt land between the ocean and the Miſſiſſippi. From thence, deſcending in the ſame latitude to the Miſſiſſippi, the change reverſes; and, if we may believe travellers, it becomes warmer there than it is in the ſame latitude on the ſea-ſide. Their teſtimony is ſtrengthened by the vegetables and animals which ſubſiſt and multiply there naturally, and do not on the ſea-coaſt. Thus catalpas grow ſpontaneouſly on the Miſſiſſippi as far as the latitude of 37, and reeds as far as 38, degrees. Perroquets even winter on the Sioto in the 39th degree of latitude. In the ſummer of 1779, when the thermometer was at 90 degrees at Monticello, and 96 degrees at Williamſburg, it was 110 degrees at Kaſkaſkia. Perhaps the mountain, which overhangs this village on the north ſide, may by its reflection have contributed ſomewhat to produce this heat.

The number of free inhabitants in this ſtate in 1790 was 454,983, and of ſlaves 292,627. The whole imports of the ſtate of Virginia amounted in 1796 to 5,268,615 dollars.

The college of William and Mary is the only public ſeminary of learning in Virginia. It was founded in the time of King William and Queen Mary, who granted to it 20,000 acres of land, and a penny a pound duty on certain tobaccoes exported from Virginia and Maryland. The aſſembly alſo gave it by temporary law a duty on liquors imported, and ſkins and furs exported. From theſe reſources it received upwards of 3000l. *communibus annis.* The buildings are of brick, ſufficient for an indifferent accommodation of perhaps 100 ſtudents. By its charter it was to be under the government of 20 viſitors, who were to be its legiſlators; and to have a preſident and ſix profeſſorſhips, which at preſent ſtand thus:—A profeſſorſhip for Law and Police; Anatomy and Medicine; Natural Philoſophy and Mathematics; Moral Philoſophy, the Law of Nature and Nations, the Fine Arts; Modern Languages; and a ſixth, called the profeſſorſhip of Brafferton, for the inſtruction of the Indians. In 1787, there were about 30 young gentlemen members of this college, a large proportion of which were law ſtudents. There are ſome flouriſhing academies in Virginia; one in Prince Edward county, one at Alexandria, one at Norfolk, one at Hanover, and others in other places.

The preſent denominations of Chriſtians in Virginia are Preſbyterians, who are the moſt numerous, and inhabit

habit the weſtern parts of the ſtate; Epiſcopalians, who are the moſt ancient ſettlers, and occupy the eaſtern and firſt ſettled parts of the ſtate. Intermingled with theſe are great numbers of Baptiſts and Methodiſts. The bulk of theſe laſt mentioned religious ſects are of the poorer ſort of people, and many of them are very ignorant (as is indeed the caſe with the other denominations), but they are generally a virtuous well-meaning ſet of people.

Virginia has produced ſome of the moſt diſtinguiſhed men that have been active in effecting the two late important revolutions in America, whoſe political and military character will rank among the firſt in the page of hiſtory. The great body of the people do not concern themſelves with politics; ſo that their government, though nominally republican, is in fact oligarchical or ariſtocratical. The Virginians who are rich, are in general ſenſible, polite, and hoſpitable, and of an independent ſpirit. The poor are ignorant and abject; all are of an inquiſitive turn, and in many other reſpects very much reſemble the people in the eaſtern ſtates. There is a much greater diſparity between the rich and the poor in Virginia than in any of the northern ſtates. A ſpirit for literary inquiries, if not altogether confined to a few, is, among the body of the people, evidently ſubordinate to a ſpirit of gaming and barbarous ſports. At almoſt every tavern or ordinary on the public road there is a billiard table, a backgammon table, cards, and other implements for various games. To theſe public houſes the gambling gentry in the neighbourhood reſort to kill time which hangs heavily upon them; and at this buſineſs they are extremely expert, having been accuſtomed to it from their earlieſt youth. The paſſion for cock-fighting, a diverſion not only inhumanly barbarous, but infinitely beneath the dignity of a man of ſenſe, is ſo predominant, that they even advertiſe their matches in the public newſpapers.

The executive powers are lodged in the hands of a governor choſen annually, and incapable of acting more than three years in ſeven. He is aſſiſted by a council of eight members. The judiciary powers are divided among ſeveral courts. Legiſlation is exerciſed by two houſes of aſſembly; the one called the *Houſe of Delegates*, compoſed of two members from each county, choſen annually by the citizens poſſeſſing an eſtate for life in 100 acres of uninhabited land, or 25 acres with a houſe on it, or in a houſe or lot in ſome town. The other called the *Senate*, conſiſting of 24 members, choſen quadrennially by the ſame electors, who for this purpoſe are diſtributed into 24 diſtricts. The concurrence of both houſes is neceſſary to the paſſage of a law. They have the appointment of the governor and council, the judges of the ſuperior courts, auditors, attorney-general, treaſurer, regiſter of the land office, and delegates to Congreſs.

Before the war, there was exported from this ſtate, *communibus annis*, to the amount of 850,000l. Virginia money, or 607,142 guineas.

The whole country before it was planted was one continued foreſt interſperſed with marſhes. No country now produces greater quantities of excellent tobacco; and the ſoil is generally ſo ſandy and ſhallow, that after they have cleared a freſh piece of ground out of the woods, it will not bear tobacco after two or three years unleſs well manured. The foreſts yield oaks, poplars, pines, cedars, cypreſſes, ſweet myrtles, cheſnuts, hickery, live oak, walnut, dog-wood, alder, hazel, chinkapins, locuſt-trees, ſaſſafras, elm, aſh, beech, with a great variety of ſweet gums and incenſe, which diſtil from ſeveral trees; pitch, tar, roſin, turpentine, plank-timber, maſts, and yards. Virginia yields alſo rice, hemp, Indian corn, plenty of paſture, with coal, quarries of ſtone, and lead and iron ore.

VIRGO, in *Aſtronomy*, one of the ſigns or conſtellations of the zodiac.

VIRGULA DIVINATORIA, divining rod. See MINE.

VIRTUAL, or POTENTIAL; ſomething that has a power or virtue of acting or doing. The term is chiefly underſtood of ſomething that acts by a ſecret inviſible cauſe, in oppoſition to actual and ſenſible.

VIRTUE, a term uſed in various ſignifications. In the general it denotes power, or the perfection of any thing, whether natural or ſupernatural, animate, or inanimate, eſſential or acceſſory. But, in its more proper or reſtrained ſenſe, virtue ſignifies a habit, which improves and perfects the poſſeſſor and his actions. See MORAL PHILOSOPHY, N° 84.

VIRTUOSO, an Italian term lately introduced into the Engliſh, ſignifying a man of curioſity and learning, or one who loves and promotes the arts and ſciences. But among us the term ſeems to be appropriated to thoſe who apply themſelves to ſome curious and quaint rather than immediately uſeful art or ſtudy; as antiquaries, collectors of rarities of any kind, microſcopical obſervers, &c.

VIRULENT, a term applied to any thing that yields a virus; that is, a contagious or malignant pus.

VISCERA, in *Anatomy*, a term ſignifying the ſame with entrails; including the heart, liver, lungs, ſpleen, inteſtines, and other inward parts of the body.

VISCIDITY, or VISCOSITY, the quality of ſomething that is viſcid or viſcous; that is, glutinous and ſticky like bird-lime, which the Latins call by the name of *viſcus*.

VISCOUNT (*Vice Comes*), was anciently an officer under an earl, to whom, during his attendance at court, he acted as deputy to look after the affairs of the country. But the name was afterwards made uſe of as an arbitrary title of honour, without any ſhadow of office pertaining to it, by Henry VI.; when, in the 18th year of his reign, he created John Beaumont a peer by the name of *Viſcount Beaumont*; which was the firſt inſtance of the kind.

A viſcount is created by patent as an earl is; his title is *Right Honourable*; his mantle is two doublings and a half of plain fur; and his coronet has only a row of pearls cloſe to the circle.

VISCUM, a genus of plants of the claſs diœcia, and in the natural ſyſtem arranged under the 48th order, *aggregatæ*. See BOTANY *Index*.

VISHNOU, that perſon in the triad of the Bramins who is conſidered as the *preſerver* of the univerſe. *Brahma* is the creator, and *Siva* the deſtroyer; and theſe two, with Viſhnou, united in ſome inexplicable manner, conſtitute *Brahme*, or the ſupreme numen of the Hindoos. See POLYTHEISM, N° 36.

VISIBLE, ſomething that is an object of ſight or viſion; or ſomething whereby the eye is affected ſo as to produce this ſenſation.

VISIER, an officer or dignitary in the Ottoman empire,

pire, whereof there are two kinds; one called by the Turks *Viſier-azem*, that is, "grand viſier," is the prime miniſter of ſtate in the whole empire. He commands the army in chief, and preſides in the divan or great council. Next to him are ſix other ſubordinate viſiers, called *viſiers of the bench;* who officiate as his counſellors or aſſeſſors in the divan.

VISION, in *Optics*, the act of ſeeing or perceiving external objects by means of the organ of ſight, the eye. See ANATOMY, N° 142, and METAPHYSICS, N° 49—54.

VISTULA, or WEISEL, a large river of Poland, which taking its riſe in the mountains ſouth of Sileſia, viſits Cracow, Warſaw, &c. and continuing its courſe northward, falls into the Baltic ſea below Dantzic.

VISUAL, in general, ſomething belonging to viſion.

VITAL, in *Phyſiology*, an appellation given to whatever miniſters principally to the conſtituting or maintaining life in the bodies of animals: thus the heart, lungs, and brain, are called *vital parts;* and the operations of theſe parts by which the life of animals is maintained are called *vital functions*.

VITELLUS, the yolk of an egg.

VITIS, or VINE, a genus of the claſs pentandria, and in the natural ſyſtem arranged under the 46th order, *Hederaceæ*. See BOTANY *Index;* and for its culture, ſee GARDENING.

VITREOUS HUMOUR OF THE EYE. See ANATOMY, N° 142.

VITRIFICATION, in *Chemiſtry*, the converſion of a body into glaſs by means of fire. See GLASS.

VITRIOL, a compound ſalt, formed by the union of iron, copper, or zinc, with ſulphuric acid, hence called from the colours white, blue, and green, according to the metal. See CHEMISTRY.

VITRIOLATED, among chemiſts, ſomething impregnated, or ſuppoſed to be ſo, with vitriol or its acid.

VITRIOLIC ACID. See *SULPHURIC Acid* and CHEMISTRY *Index*.

VITRUVIUS POLLIO, MARCUS, a very celebrated Roman architect, was, according to the common opinion, born at Verona, and lived in the reign of Auguſtus, to whom he dedicated his excellent treatiſe on architecture, divided into ten books. William Philander's edition of this celebrated work is eſteemed. Claudius Perrault has given an excellent tranſlation of it in French, with learned notes. There are alſo ſeveral Engliſh tranſlations of Vitruvius.

VITUS'S DANCE. See MEDICINE, N° 284.

VIVERRA, the WEASEL; a genus of quadrupeds belonging to the order of feræ. See MAMMALIA *Index*.

VIVES. See FARRIERY.

VIVIPAROUS, in *Natural Hiſtory*, an epithet applied to ſuch animals as bring forth their young alive and perfect; in contradiſtinction to thoſe that lay eggs, which are called *oviparous* animals.

UKRAINE, a large country of Europe, lying on the borders of Turkey in Europe, Poland, Ruſſia, and Little Tartary. Its name properly ſignifies a *frontier*. By a treaty between Ruſſia and Poland in 1693, the latter remained in poſſeſſion of all that part of the Ukraine lying on the weſt ſide of the river Dnieper, which is but indifferently cultivated; while the country on the eaſt ſide, inhabited by the Coſſacs, is in much better condition. The Ruſſian part is compriſed in the government of Kiof; and the empreſs of Ruſſia having obtained the Poliſh palatinate of Kiof, by the treaty of partition in 1793, the whole of the Ukraine, on both ſides of the Dnieper, belongs now to that ambitious and formidable power. The principal town is Kiof.

ULCER, in *Surgery*. See SURGERY *Index*.

ULCER, in *Farriery*. See FARRIERY.

ULEX, a genus of plants of the claſs of diadelphia, and in the natural ſyſtem arranged under the 32d order, *Papilionaceæ*. See BOTANY *Index*.

ULIETEA, one of the Society iſlands in the South ſea. This iſland is about 21 leagues in circuit. Its productions are plantains, cocoa-nuts, yams, hogs, and fowl; the two latter of which are ſcarce. The ſoil on the top of one of the hills was found to be a kind of ſtone marle; on the ſides were found ſome ſcattered flints, and a few ſmall pieces of a cavernous or ſpongy ſtone lava, of a whitiſh colour, which ſeemed to contain ſome remains of iron, ſo that it may poſſibly be here lodged in the mountains in a great quantity. Nothing was ſeen on this iſland to diſtinguiſh either its inhabitants, or their manners, from the other neighbouring iſlands. The firſt Europeans who landed on this ſhore were Mr (now Sir Joſeph) Banks and Dr Solander; they were received by the natives in the moſt courteous manner, reports concerning them having been their harbingers from Otaheite. Every body ſeemed to fear and reſpect them, placing in them at the ſame time the utmoſt confidence: behaving, as if conſcious that their viſitors poſſeſſed the power of doing them miſchief without a diſpoſition to make uſe of it.

ULIGINOUS, in *Agriculture*, an appellation given to a moiſt, mooriſh, and fenny ſoil.

ULLAGE, in gauging, is ſo much of a caſk or other veſſel as it wants of being full.

ULM, a free and imperial city of Germany, in the circle of Swabia, ſeated on the river Iller. It is a pretty large place, defended by fortifications; and the inhabitants are Proteſtants. Here the archives of the circle are depoſited, and it carries on a very great trade. The elector of Bavaria became maſter of it in 1702, by a ſtratagem; but, in 1704, the French being vanquiſhed at the battle of Hochſtet, the Bavarians ſurrendered it by capitulation. The Roman Catholics have but two churches, all the reſt belonging to the Proteſtants. E. Long. 10. 12. N. Lat. 48. 25.

ULMUS, a genus of plants belonging to the claſs of pentandria; and in the natural ſyſtem arranged under the 53d order, *Scabridæ*. See BOTANY *Index*.

ULSTER, the moſt northerly province of Ireland. In Latin it is called *Ultonia*, in Iriſh *Cui Guilly;* and gives the title of *earl* to the dukes of York of the royal family. It is bounded by the Atlantic ocean on the weſt, St George's channel and the Iriſh ſea on the eaſt, the Deucaledonian ocean on the north, and on the ſouth and ſouth-weſt the provinces of Leinſter and Connaught. Its greateſt length is near 120 miles, its breadth about 100; and its circumference, including the windings and turnings, 460; containing 9 counties, 58 market-towns and boroughs, 1 archbiſhopric, 6 biſhoprics, and 214 pariſhes. Ulſter abounds in lakes and rivers, which ſupply it with variety of fine fiſh, eſpecially ſalmon, beſides what it has from the ſea, with which a great part of it is bounded. The ſouthern parts of it are rich, fertile, well cultivated, and incloſed; but the greater part of the northern is open and mountainous.—The towns of this province are in general the neateſt and beſt built of any in Ireland, as well as the farm-houſes; which in moſt parts of the kingdom are conſtructed of no better materials than clay and ſtraw. The inhabitants of Ulſter are alſo more like the Engliſh in their manners and dialect than thoſe of the other three provinces: for as it includes within itſelf the whole, or by far the greater part, of the linen manufactory, the beſt branch of trade in the kingdom, they have conſequently the greateſt intercourſe with England. An Engliſhman, in ſome parts of it, indeed, will imagine himſelf, from the ſimilarity of their language and manners, in his own country. This province had anciently petty kings of its own. It was firſt ſubjected to the Engliſh in the reign of Henry II. by John Courcy, the firſt who bore the title of *earl of Ulſter*; but it afterwards threw off the yoke, and was never entirely reduced till the reign of James I. when great numbers of Scots by his encouragement went and ſettled in it. Of theſe, moſt of the preſent inhabitants are the deſcendants. This province was the firſt and principal ſcene of the bloody maſſacre in 1641.

ULTERIOR, in *Geography*, is applied to ſome part of a country or province, which, with regard to the reſt of that country, is ſituated on the farther ſide of the river, mountain, or other boundary which ſeparates the two countries.

ULTRAMARINE, a beautiful blue colour uſed by the painters, prepared from the lapis lazuli by calcination. See Lazulite, Mineralogy *Index*.

ULTRAMONTANE, ſomething beyond the mountains. The term is principally applied in relation to France and Italy, which are ſeparated by the Alps.

ULVA, a genus of plants of the claſs of cryptogamia. See Botany *Index*.

ULUG Beig, a Perſian prince and learned aſtronomer, was deſcended from the famous Tamerlane, and reigned at Samarcand about 40 years; after which he was murdered by his own ſon in 1449. His catalogue of the fixed ſtars, rectified for the year 1434, was publiſhed at Oxford by Mr Hyde, in 1665, with learned notes. Mr Hudſon printed in the Engliſh Geography Ulug Beig's Tables of the Longitude and Latitude of Places; and Mr Greaves publiſhed, in Latin, his Aſtronomical Epochas, at London, in 1650. See Astronomy *Index*.

ULYSSES, king of Ithaca, the ſon of Laertes, and father of Telemachus, and one of thoſe heroes who contributed moſt to the taking of Troy. After the deſtruction of that city, he wandered for 10 years; and at laſt returned to Ithaca, where, with the aſſiſtance of Telemachus, he killed Antinous and other princes who intended to marry his wife Penelope and ſeize his dominions. He at length reſigned the government of the kingdom to his ſon Telemachus; and was killed by Telegonus, his ſon by Circe, who did not know him. This hero is the ſubject of the Odyſſey.

UMBELLA, an Umbel, a ſpecies of receptacle; or rather a mode of flowering, in which a number of ſlender footſtalks proceed from the ſame centre, and riſe to an equal height, ſo as to form an even and generally round ſurface at top. See Botany.

UMBELLATÆ, the name of a claſs in Ray's and Tournefort's methods, conſiſting of plants whoſe flowers grow in umbels, with five petals that are often unequal, and two naked ſeeds that are joined at top and ſeparated below.

The ſame plants conſtitute the 45th order of Linnæus's Fragments of a Natural Method. See Botany.

UMBELLIFEROUS plants, are ſuch as have their tops branched and ſpread out like an umbrella.

UMBER, or Umbre, a foſſil brown or blackiſh ſubſtance, uſed in painting. See Mineralogy *Index*.

UMBILICAL, among anatomiſts, ſomething relating to the umbilicus or navel.

UMBRELLA, a moveable canopy, made of ſilk or other cloth ſpread out upon ribs of whale-bone, and ſupported by a ſtaff, to protect a perſon from rain, or the ſcorching beams of the ſun.

UMPIRE, a third perſon choſen to decide a controverſy left to arbitration.

UNCIA, in general, a Latin term, denoting the twelfth part of any thing; particularly the twelfth part of a pound, called in Engliſh an *ounce*; or the twelfth part of a foot, called an *inch*.

UNCTION, the act of anointing or rubbing with oil or other fatty matter.

Unction, in matters of religion, is uſed for the character conferred on ſacred things by anointing them with oil. Unctions are very frequent among the Hebrews. They anointed both their kings and high-prieſts at the ceremony of their inauguration. They alſo anointed the ſacred veſſels of the tabernacle and temple, to ſanctify and conſecrate them to the ſervice of God. The unction of kings is ſuppoſed to be a ceremony introduced very late among the Chriſtian princes. It is ſaid that none of the emperors were ever anointed before Juſtinian or Juſtin. The emperors of Germany took the practice from thoſe of the eaſtern empire: King Pepin of France was the firſt who received the unction. In the ancient Chriſtian church, unction always accompanied the ceremonies of baptiſm and confirmation. Extreme unction, or the anointing perſons in the article of death, was alſo practiſed by the ancient Chriſtians, in compliance with the precept of St James, chap v. 14th and 15th verſes; and this extreme unction the Romiſh church has advanced to the dignity of a ſacrament. It is adminiſtered to none but ſuch as are affected with ſome mortal diſeaſe, or in a decrepit age. It is refuſed to impenitent perſons, as alſo to criminals. The parts to be anointed are the eyes, the ears, the noſtrils, the mouth, the hands, the feet, and the reins. The laity are anointed in the palms of the hands, but prieſts on the back of it; becauſe the palms of their hands have been already conſecrated by ordination.

The oil with which the ſick perſon is anointed repreſents the grace of God, which is poured down into the ſoul, and the prayer uſed at the time of anointing expreſſes the remiſſion of ſins thereby granted to the ſick perſon; for the prayer is this: "By this holy unction, and his own moſt pious mercy, may the Almighty God forgive thee whatever ſins thou haſt committed *by the ſight*," when the eyes are anointed; *by the hearing*, when the ears are anointed; and ſo of the other ſenſes *.

UNDECAGON, is a regular polygon of 11 ſides.

UNDECEMVIR, a magiſtrate among the ancient Athenians, who had 10 other colleagues or aſſociates joined

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* *The Sincere Chriſtian inſtructed from the Written Word.*

joined with him in the ſame commiſſion. The functions of the undecemviri at Athens were much the ſame with thoſe of the late *prevots de marechauſſe* in France. They took care of the apprehending of criminals; ſecured them in the hands of juſtice; and when they were condemned, took them again into cuſtody, that the ſentence might be executed on them. They were choſen by the tribes, each tribe naming its own; and as the number of the tribes after Calliſthenes was but 10, which made 10 members, a ſcribe or notary was added, which made the number 11.

UNDERSTANDING. See METAPHYSICS and LOGIC.

UNDERWALDEN, a canton of Switzerland, and the ſixth in rank. It is bounded on the north by the canton of Lucern and by the lake of the Four Cantons, on the eaſt by the high mountains which ſeparate it from the canton of Bern, and on the weſt by the canton of Bern. The religion of this canton is the Roman Catholic.

UNDULATION, in *Phyſics*, a kind of tremulous motion or vibration obſervable in a liquid, by which it alternately riſes and falls like the waves of the ſea.

UNGUENT, or OINTMENT, in *Medicine* and *Surgery*, a topical remedy or compoſition, chiefly uſed in the dreſſing of wounds or bliſters. See MATERIA MEDICA.

UNICORN, an animal famous among the ancients, and thought to be the ſame with the rhinoceros.

Sparmann informs us, that the figure of the unicorn deſcribed by the ancients has been found delineated by the Sneſe Hottentots on the plain ſurface of a rock in Caffraria; and therefore conjectures, that ſuch an animal either does exiſt at preſent in the internal parts of Africa, or at leaſt once did ſo. Father Lobo affirms that he has ſeen it. Mr Barrow in his *Travels in Southern Africa*, affords additional reaſon to believe in the exiſtence of this curious animal.

UNICORN-Fiſh. See MONODON, CETOLOGY *Index*.

UNIFORM, denotes a thing to be ſimilar, or conſiſtent either with another thing, or with itſelf, in reſpect of figure, ſtructure, proportion, or the like; in which ſenſe it ſtands oppoſed to difform.

UNIFORMITY, regularity, a ſimilitude or reſemblance between the parts of a whole. Such is that we meet with in figures of many ſides, and angles reſpectively equal, and anſwerable to each other. A late ingenious author makes beauty to conſiſt in uniformity, joined or combined with variety. Where the uniformity is equal in two objects, the beauty, he contends, is as the variety; and where the variety is equal, the beauty is as the uniformity.

UNIFORMITY, is particularly uſed for one and the ſame form of public prayers, and adminiſtration of ſacraments, and other rites, &c. of the church of England, preſcribed by the famous ſtat. 1 Eliz. and 13 and 14 Car. II. cap. 4. called the *Act of Uniformity*. See LITURGY.

UNION, a junction, coalition, or aſſemblage of two or more different things in one.

UNION, or *The Union*, by way of eminence, is more particularly uſed to expreſs the act by which the two ſeparate kingdoms of England and Scotland were incorporated into one, under the title of *The kingdom of Great Britain*. This union, in vain attempted by King James I. was at length effected in the year 1707, 6 Annæ, when 25 articles were agreed to by the parliament of both nations; the purport of the moſt conſiderable being as follows:

1. That on the firſt of May 1707, and for ever after, the kingdoms of England and Scotland ſhall be united into one kingdom, by the name of *Great Britain*.

2. The ſucceſſion to the monarchy of Great Britain ſhall be the ſame as was before ſettled with regard to that of England.

3. The united kingdom ſhall be repreſented by one parliament.

4. There ſhall be a communication of all rights and privileges between the ſubjects of both kingdoms, except where it is otherwiſe agreed.

9. When England raiſes 2,000,000l. by a land-tax, Scotland ſhall raiſe 48,000l.

16, 17. The ſtandards of the coin, of weights, and of meaſures, ſhall be reduced to thoſe of England throughout the united kingdoms.

18. The laws relating to trade, cuſtoms, and the exciſe, ſhall be the ſame in Scotland as in England. But all the other laws of Scotland ſhall remain in force; but alterable by the parliament of Great Britain. Yet with this caution, that laws relating to public policy are alterable at the diſcretion of the parliament; laws relating to private right are not to be altered but for the evident utility of the people of Scotland.

22. Sixteen peers are to be choſen to repreſent the peerage of Scotland in parliament, and 45 members to ſit in the houſe of commons.

23. The 16 peers of Scotland ſhall have all privileges of parliament; and all peers of Scotland ſhall be peers of Great Britain, and rank next after thoſe of the ſame degree at the time of the union, and ſhall have all privileges of peers, except ſitting in the houſe of lords, and voting on the trial of a peer.

Theſe are the principal of the 25 articles of union, which are ratified and confirmed by ſtatute 5 Ann. c. 8. in which ſtatute there are alſo two acts of parliament recited; the one of Scotland, whereby the church of Scotland, and alſo the four univerſities of that kingdom, are eſtabliſhed for ever, and all ſucceeding ſovereigns are to take an oath inviolably to maintain the ſame; the other of England, 5 Annæ, c. 6. whereby the acts of uniformity of 13 Eliz. and 13 Car. II. (except as the ſame had been altered by parliament at that time), and all other acts then in force for the preſervation of the church of England, are declared perpetual; and it is ſtipulated, that every ſubſequent king and queen ſhall take an oath inviolably to maintain the ſame within England, Ireland, Wales, and the town of Berwick-upon-Tweed. And it is enacted, that theſe two acts "ſhall for ever be obſerved as fundamental and eſſential conditions for the union."

Upon theſe articles and act of union, it is to be obſerved, 1. That the two kingdoms are ſo inſeparably united, that nothing can ever diſunite them; except the mutual conſent of both, or the ſucceſsful reſiſtance of either, upon apprehending an infringement of thoſe points which, when they were ſeparate and independent nations, it was mutually ſtipulated ſhould be "fundamental and eſſential conditions of the union." 2. That whatever elſe may be deemed "fundamental and eſſential conditions," the preſervation of the two churches, of England and Scotland, in the ſame ſtate that they were in at the time of the union, and the maintenance of of the acts of uniformity which eſtabliſhed the liturgy, are expreſsly declared ſo to be. 3. That therefore any alteration in the conſtitution of either of theſe churches, or in the liturgy of the church of England (unleſs with the conſent of the reſpective churches, collectively or repreſentatively given), would be an infringement of theſe "fundamental and eſſential conditions," and greatly endanger the union. 4. That the municipal laws of Scotland are ordained to be ſtill obſerved in that part of the iſland, unleſs altered by parliament; and as the parliament has not yet thought proper, except in a few inſtances, to alter them, they ſtill, with regard to the particulars unaltered, continue in full force.

For an account of the union of Ireland with Great Britain, thus forming the *united kingdom of Great Britain and Ireland*, ſee IRELAND, N° 120.

UNISON, in *Muſic*. See INTERVAL.

UNIT, or UNITY, in *Arithmetic*, the number one; or one ſingle individual part of diſcrete quantity.

UNITARIANS, in eccleſiaſtical hiſtory, a name given to thoſe who confine the glory and attribute of divinity to the One only great and ſupreme God, and Father of our Lord Jeſus Chriſt.

UNITED BRETHREN, or *Unitas Fratrum*; a ſociety of Chriſtians, whoſe chief reſidence is at Herrnhut in Saxony. They are commonly called Moravians, from their original country, and Herrnhuters, from their chief place of reſidence. Some account of this ſociety has already been given under HERRNHUT; but as that account may, by ſome, not be deemed ſufficiently full, we ſhall here add a ſummary of their inſtitutes, derived from a communication by one of their own clergy.

Though the church of the United Brethren is epiſcopal, their biſhops poſſeſs no elevation of rank or preeminent authority, their church being governed by ſynods or conſiſtories from all the congregations, and by ſubordinate bodies, called conferences. The ſynods are generally held once in ſeven years. In the firſt ſitting a preſident is choſen; and the elders appointed by the former ſynod to ſuperintend the unity, lay down their office, though they ſtill form a part of the aſſembly, as well as the biſhops, the lay elders, and thoſe miniſters who have the inſpection of ſeveral congregations in one province.

Queſtions of importance, or of which the conſequences cannot be foreſeen, are decided by lot, though this is never uſed till after mature deliberation and fervent prayer. In the ſynods, the ſtate of the unity, and the concerns of the congregations and miſſions, are taken into conſideration.

Towards the concluſion of every ſynod, a kind of executive board is appointed, called the *elders conference of the unity*, conſiſting of 13 elders, and divided into four committees or departments, one for ſuperintending miſſions into heathen countries; a ſecond for watching over the conduct of congregations; a third for managing the economical concerns of the unity, and a fourth for maintaining the diſcipline of the ſociety. Theſe conferences, however, are amenable to a higher committee, called the elders conference, the powers of which are very extenſive. It appoints and removes every ſervant in the unity, authoriſes the biſhops to ordain preſbyters or deacons, and to conſecrate other biſhops, and in ſhort, poſſeſſes the ſupreme executive power over the whole ſociety.

A biſhop of the United Brethren can diſcharge no office but by the appointment of the ſynod, or of the elders conference. Indeed their deacons can perform every office of the biſhops, except ordination, and appear to confirm young perſons when they firſt become candidates for the communion. Even female deacons are employed for the purpoſe of privately admoniſhing their own ſex, and viſiting them in caſes of ſickneſs. There are alſo lay elders, whoſe buſineſs it is to watch over the conſtitution and diſcipline of the unity; to enforce the obſervance of the laws of the country in which miſſions are eſtabliſhed, and to guard the privileges conferred on the brethren by the government under which they live.

On Sunday, beſides the public prayers, one or two ſermons are preached in every church, and after the morning ſervice, an exhortation is given to the children. Previous to the holy communion, which is adminiſtered on ſome Sunday once a month, and on Maunday Thurſday, each perſon before he communicates, muſt converſe on the ſtate of his ſoul with one of the elders. Love feaſts are frequent, and on Maunday Thurſday the ſociety have a ſolemn footwaſhing.

Our limits will not permit us to give a ſyſtematic view of the doctrinal tenets of the Brethren. Though they acknowledge no other ſtandard of truth than the ſacred ſcriptures, they adhere to the Augſburg confeſſion, and ſpeak reſpectfully of the 39 articles of the church of England. They profeſs to believe that the kingdom of Chriſt is not confined to any particular party, community, or church; and they conſider themſelves as ſpiritually joined in the bond of Chriſtian love to all who are taught of God, and belong to the univerſal church of Chriſt, however much they may differ in forms, which they deem non-eſſentials. For a fuller account of this ſociety, ſee *Crantz's Ancient and Modern Hiſtory of the Proteſtant Church of the United Brethren*, London 1780, and *An Expoſition of Chriſtian Doctrine, as taught in the Proteſtant Church of the United Brethren*, London 1784.

1 Situation and extent.

UNITED PROVINCES, otherwiſe called the *Republic of Holland*, or the *Batavian republic*, a maritime country of Europe, occupying that part of the Netherlands which lies between Auſtrian Flanders and Brabant, now the French departments of *Lys*, *Eſcaut*, *Deux Nethes* and *Dyle* on the ſouth, and the diſtrict of Eaſt Frieſland on the north-eaſt; being bounded on the north and weſt by the German ocean or North ſea, and on the eaſt by the kingdom of Weſtphalia. They are ſituated between the parallels of 51° 10′, and 53° 35′ N. lat. and between 3° 10′, and 7° 5′ E. long. In Britiſh miles the length of this country, from north to ſouth, is eſtimated at 165, its breadth from weſt to eaſt about 100, and its area at 10,000 ſquare miles.

2 Diviſion.

Before the French revolution, this part of the Low Countries was divided into ſeven provinces, viz. GUELDERLAND or GELDERS, HOLLAND, ZEALAND, UTRECHT, FRIESLAND, OVERYSSEL and GRONINGEN, beſides the dependencies of *Dutch* BRABANT and *Dutch* FLANDERS. Of late the whole has formed eight departments, which, except that called the Generalité lands, were diſtinguiſhed by the old names. The following table gives a general view of the ſubdiviſions, area in geographical miles, population and chief towns of theſe provinces.

Provinces.	*Subdiviſions.*	*Area.*	*Population in* 1796.	*Chief Towns.*
I. GUELDERLAND.	Nimeguen Zutphen Arnheim	1840	217,828	NIMEGUEN, Zutphen, Arnheim.
II. HOLLAND.	North Holland South Holland	2000	828,542	AMSTERDAM, Rotterdam, Hague, Leyden, Haarlem, Helvoetſluys and Alkmaer.
III. ZEALAND.	Weſt Zealand Eaſt Zealand	uncertain	82,212	MIDDLEBURG, Fluſhing.
IV. UTRECHT.	Emeland Abhoude Montfort Wyk	510	92,904	UTRECHT, Amersfort.
V. FRIESLAND.	Ooſtergo Weſtergo Zevenwolde Northern iſlands	1155	161,513	LEEWARDEN, Dockum, Franeker, Harlingen, Bolſwert.
VI. OVERYSSEL.	Salland Twenthe Wollenhoven Drenthe	1792	135,060	DEVENTER, Zwol, Campen, Coeverden.
VII. GRONINGEN.	Groningen Ommeland	640	114,555	GRONINGEN, Winchoten.
GENERALITY lands (A)	Drent Dutch Brabant	2000	247,849	Bois-le-duc, Breda, Bergen-op-Zoom.
			1,880,563	

A great part of theſe provinces is compoſed of iſlands formed by the mouths of the large rivers which here diſembogue their waters into the German ocean. The principal iſlands are *Walcheren*, *Jooſtland*, *South* and *North Beveland*, and *Wolferſdyk*, compoſing Weſt Zealand; *Schowen*, *Duiveland*, *Fertholen*, and *St Phillipsland*, forming Eaſt Zealand; *Goeree* in *South Holland*, the *Texel*, *Vlieland*, and *Ameland*, to the weſt and north of Frieſland.

3 Colonies. The Dutch had formerly conſiderable colonial territory; but this is now reduced to part of Java, Sumatra, and the Molucca iſlands, with ſome other ſettlements in the Eaſt Indies; ſome trifling factories on the Guinea coaſt; St Euſtatius and part of Surinam in South America.

4 Surface, ſoil, &c. The face of the country is, in general, extremely uniform, conſiſting of large tracts of marſhy paſtures, or ſandy heaths, interſperſed with ſeveral large rivers, and numerous canals. There are a few hills in the eaſtern diſtricts, but the coaſts are ſo low, that, but for the *dykes* or ſea walls, they would be inundated by the ſea. The ſoil conſiſts almoſt entirely of *alluvial* earth and vegetable mold, and is very productive. The climate is moiſt, inconſtant, and peculiarly inſalubrious to ſtrangers; intermittent fevers and ſimilar diſeaſes, the attendants on a marſhy and watery ſoil, being extremely frequent. The winters are colder and the ſummers hotter than in Britain.

5 Rivers and lakes. The principal rivers of the United Provinces are the Rhine, the Maeſe or Meuſe, and the Eſcaut or Scheldt, which ſeparates them from French Flanders. There are few lakes of any note, except the ſea of Haerlem, near the Zuyder Zee.

6 Produce and agriculture. There is little intereſting in the natural hiſtory of Holland; the animals and plants reſembling thoſe of the adjacent countries of France and Germany, and its mineral products being extremely few. Its chief artificial products are flax, tobacco, madder and flower roots, butter and cheeſe. The ſtate of agriculture is but little advanced; as almoſt the whole country is under graſs, and the corn produced is not nearly ſufficient for home conſumption.

7 Progreſſive geography. The changes which the coaſts of the Dutch provinces have undergone, in conſequences of the ſhifting of the beds of rivers, the encroachments or retiring of the ſea, and tempeſts from the German ocean, render their progreſſive geography an intereſting object. We find that in the latter periods of the Roman empire, the river Rhine divided itſelf into two great branches at Burginaſium, the modern Schenk, about five miles north-weſt of Colonia Trajana, near the preſent Cleves. The ſouthern branch joined the Meuſe at the town of Moſa or Muvi, while the northern branch paſſed by Durſtadt, Utrecht, and Leyden, to the ocean. The northern branch of the Rhine was joined to the Yſſel by the canal of Druſus (ſee *BATAVORUM Inſula*), while this latter river flowed into a conſiderable lake called Flevo, now a ſouthern portion of the Zuyder Zee. When the canal of Druſus was

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(A) See each of theſe articles in the general alphabet.

was neglected, the waters of the Rhine poured into the Yſſel with ſuch violence as to increaſe the lake of Flevo to a great expanſe of waters, ſo that inſtead of a river which once ran from that lake to the ſea for nearly 50 Roman miles, there was opened the wide gulf which now forms the entrance. In the mean time, the northern branch of the Rhine became much diminiſhed, and the canal of Druſus gradually diſappeared. The eſtuaries of the Meuſe and the Scheldt being open to great inroads from the ſea, have alſo materially changed their figure and poſition; and the latter in particular, which once formed merely a triangular iſland, divided into four or five ſmaller branches, which are now extenſive creeks, dividing the iſlands of Zealand and South Holland. In the beginning of the 15th century, the eſtuary of the Meuſe ſuddenly formed a vaſt lake to the ſouth-eaſt of Dort, overwhelming 72 villages, and 100,000 inhabitants. By a ſubſequent change, the Rhine was again ſubdivided, the northern branch falling into the Leck, while the ſouthern formed the modern Waal.

The early hiſtory of theſe provinces, from their ſubjection by the Romans, till they fell under the dominion of the Spaniſh monarchy, has been already given under the article NETHERLANDS, ſo that we have here to relate only thoſe tranſactions which have taken place ſince the acceſſion of Philip II. to the crown of Spain (B).

8
State of the Dutch provinces at the acceſſion of Philip II.
An. 1556.

At the death of Charles V. the Dutch provinces were in a very flouriſhing condition. In this ſmall tract were then reckoned not fewer than 350 large walled cities, and 6300 conſiderable towns or large villages, all become rich by their application to arts and commerce. The ſame application had diffuſed a ſpirit of independence among the inhabitants, who were jealouſly alive to every invaſion of their rights and privileges. The reformed religion had made conſiderable progreſs among all ranks, and the doctrines of Calvin had been embraced by a great majority of the people. Hence, nothing could be more impolitic than the meaſures taken by Philip to advance the cauſe of popery, and to enforce obedience to the tyrannical acts of his deputies. The eſtabliſhment of a court of inquiſition, the increaſe of the number of biſhoprics, the appointment of Cardinal Grandvele to be chief counſellor to the ducheſs of Parma, then regent of the Netherlands, and the enormous taxes levied to ſupport the Spaniſh forces, were no trifling grievances, and created ſuch a ſpirit of diſaffection, that when the ducheſs aſſumed the reins of government, in the year 1560, the murmurs of the people could no longer be ſuppreſſed.

9
Diſcontent occaſioned by the tyrannical meaſures of Philip.
An. 1564.

A deputation of the malcontents, at the head of whom were William prince of Orange, and his brother Louis of Naſſau, with the counts of Egmont and Horn, waited on the ducheſs at Bruſſels, and inſiſted either on the diſmiſſal of Cardinal Grandvele, or the calling of an aſſembly of the ſtates-general. The ducheſs thought proper to comply with the former of theſe requeſts, but as that miniſter was ſucceeded by two of his creatures, who trod exactly in his footſteps, and in particular increaſed the religious perſecutions, and the power of the inquiſition, the popular ferment became greater than ever. The patriots ſent Count Egmont to Madrid, to lay their grievances before the king; but that monarch with his accuſtomed inſincerity, returned a favourable anſwer to their remonſtrances, without changing any of the obnoxious meaſures of the government at Bruſſels. In the mean time the diabolical combination that had been formed between Charles IX. of France and Iſabella of Spain, for the maſſacre of the proteſtants, which ſoon after took place, had been whiſpered in the Low Countries, and in conſequence a general aſſociation was formed for the purpoſe of aboliſhing the court of inquiſition. This aſſociation, headed by Henry de Brodenrode, a deſcendant of the earls of Holland, waited on the regent in ſuch a formidable body, that ſhe was obliged to promiſe the exertion of her utmoſt influence towards obtaining their demands. It is ſaid, however, that ſhe could obtain no better terms from the bigotted Philip than that heretics ſhould in future be hanged inſtead of burnt.

10
The people break out into open rebellion.

As the people found that their dutiful remonſtrances could obtain no redreſs, they determined to take into their own hands the neceſſary reformation. In ſeveral towns in Flanders, the people aſſembled, deſtroyed churches, pulled down images, and committed other acts of violence. The principal inhabitants, however, while they were preparing to reſiſt the oppreſſive acts of the government, behaved with more temperance and moderation; a new oath of allegiance had been exacted, and this the counts of Egmont and Horn, probably with a view to temporiſe, were induced to take, but the prince of Orange ſteadily refuſed, and retired into Germany, whither he was followed by great numbers of all ranks and conditions, ſo that within a few days 100,000 families had left the Low Countries. This emigration ſo much alarmed the ducheſs of Parma, that ſhe reſigned the regency.

11
Duke of Alva appointed governor of the Netherlands.

The ducheſs was ſucceeded by the duke of Alva, who had been ſent into the Netherlands with an army of 10,000 veteran troops, to intimidate the people, and enforce obedience to the civil power. We have already drawn the character of this bloody man (ſee ALVA), and have ſhewn how well he was calculated to execute the orders of a tyrannical and bigotted maſter. He no ſooner entered on his government than the whole country was filled with terror; Counts Egmont and Horn were ignominiouſly executed, and the eſtates of the prince of Orange were confiſcated.

12
The prince of Orange takes the command of the patriots.

This prince and his brother had been labouring to ſupport the cauſe of their injured countrymen among the German

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(B) There is no part of the hiſtory of nations more intereſting in itſelf, or more replete with uſeful leſſons to rulers and to ſubjects, than that which records the ſtruggles of a brave people to preſerve or regain their liberties and independence. Hence the glorious conteſt which the Dutch provinces maintained againſt the power of Spain, and by which they finally triumphed over tyranny and oppreſſion, might well deſerve a much fuller detail than our confined limits will enable us to afford. In the compendious view which we have here given of theſe tranſactions, we have endeavoured to catch the more prominent features, and thus in ſome meaſure preſerve the ſpirit of the picture. We may refer our readers for a minute account of theſe events to *The Modern Univerſal Hiſtory*, vol. xxxi. and Watſon's *Hiſtory of the Reigns of Philip II. and Philip III.*

German princes, and had raiſed a detachment of Germans, by which they were enabled to make head againſt the regent. The prince of Orange, who had been always a favourite with the people, was now rendered more popular in conſequence of his ſufferings in their cauſe, and was invited to take the command of the armed bodies which were preparing to reſiſt the duke of Alva.

13
Commencement of hoſtilities.
An. 1569.

The prince firſt penetrated into Brabant, and attempted to ſurpriſe Ruremond, but was defeated by a detachment of the Spaniſh army; but his brother ſoon after overpowered a body of Spaniards, and killed 600. In a ſubſequent engagement, however, with the main body of Alva's army, Prince Louis was entirely defeated, and all his infantry cut in pieces. The prince of Orange finding that he could not at preſent keep the field againſt ſo formidable an enemy, and that his ſoldiers deſerted in conſequence of his ill ſucceſs and want of pay, was, in 1569, obliged to diſband his army, and return to Germany.

14
Cruelty of the duke of Alva.

The duke of Alva did not fail to make the moſt of his ſucceſs. All the priſoners taken in the laſt campaign were put to death, and the 100th part of every man's eſtate, with a tenth of all merchandiſe, were exacted as an annual payment from the inhabitants, under the penalty of military execution. The ſtates offered to pay an annual ſubſidy of 2,000,000 florins, in place of theſe taxes; but theſe offers were rejected with diſdain.

15
A fleet fitted out by the patriots.
An. 1571.

The people thus driven to deſpair, were reſolved to ſtrain every nerve to reſiſt theſe oppreſſive acts. The tradeſmen in the towns ſhut their ſhops, and the peaſants refuſed to bring proviſions to the markets. In the mean time a ſquadron of ſhips, which is known by the name of *gueux*, had been fitted out by the prince of Orange, and the command given to Lumey. The trifling ſucceſs of this ſquadron, which had captured Briel, in the iſland of Voorn, and repulſed a force ſent againſt it by the duke of Alva, induced the Zealanders to collect all their ſhips, and alſo oppoſe the enemy at ſea. A conſiderable advantage was gained by this fleet, againſt a Spaniſh ſquadron commanded by the duke of Medina Celi. The duke was entirely defeated, many of his ſhips were taken, and the Zealanders carried off a booty of nearly 1,000,000 of livres.

16
Succeſſes of the Orange party.

To increaſe his army, the governor had draughted men from the garriſons of moſt of the fortified towns, and thus expoſed theſe to the attacks of the patriots. Accordingly, Lewis of Naſſau ſurpriſed Mons, the count de Bergues gained poſſeſſion of ſeveral towns in Overyſſel, Guelderland, and Frieſland; while another party of the malcontents made themſelves maſters of North Holland. The duke of Alva now began to feel that he had gone too far, and attempted when too late, to conciliate the good opinion of the people. He publiſhed an edict conſenting to remit the moſt oppreſſive taxes, if the ſtate could ſuggeſt any other method of raiſing the neceſſary ſupplies, and he convoked the ſtates-general of the Provinces to aſſemble at the Hague. His promiſes and his threats were, however, now diſregarded; and the ſtates who, in contempt of his authority had aſſembled at Dordrecht, openly eſpouſed the cauſe of their country, declared the prince of Orange commander of the national forces, and raiſed a conſiderable ſum for the payment of his troops.

The prince's forces now amounted to 15,000 foot and 7000 horſe, with which he advanced into Brabant, and took Ruremond by aſſault. He then poſſeſſed himſelf of Mechlin, Oudenarde, and Dendermond, and having levied contributions on thoſe inhabitants who adhered to the government, he marched towards Mons, then beſieged by the duke of Alva, with an intention to raiſe the ſiege, by bringing the duke to a general action. This, however, Alva declined, and Mons was obliged to capitulate.

17
Reverſes.

In the midſt of theſe ſucceſſes, a damp was thrown over the ardour of the patriots, by the news of the horrid maſſacre of St Bartholomew *, and in the ſame degree the ſpirits of the Spaniards revived. The prince of Orange found himſelf obliged to retire to the province of Holland, leaving the cities which he had taken at the mercy of the army. Mechlin opened its gates, and was pillaged without mercy, while the other towns were evacuated by the garriſons, and loaded with heavy impoſitions. In a ſhort time nothing remained to the patriots, but the provinces of Holland and Zealand; but theſe ſtood firm in the cauſe of liberty, and ſoon became the ſeat of a ſanguinary warfare. Frederick de Toledo was detached by the duke of Alva to reduce the inſurgents in theſe quarters. He quickly reduced Waerden, where his ſoldiers committed the moſt horrid acts of barbarity. The capture of this place was followed by that of Haerlem after an obſtinate reſiſtance.

18
Naval victories of the Zealanders.

To balance this ill ſucceſs by land, however, the Zealanders obtained many important advantages by ſea. They attacked the harbour of Antwerp, and carried off ſeveral ſhips; and when the governor equipped a ſquadron to oppoſe them, it was thrice encountered by Wertz, the Zealand admiral, and totally defeated. In the mean time the Spaniſh forces, under Frederick of Toledo, conſiſting of 16000 veterans, ſat down before Alkmaer, the capital of Holland, a town without regular fortifications, and defended only by 300 burghers and 800 ſoldiers, in great want of proviſions, and without any proſpect of ſpeedy relief; yet this place, though attacked with great vigour, by a battery of 20 pieces of heavy cannon, which effected a breach in one of the walls, held out againſt every attempt, and the Spaniſh ſoldiers who attempted to ſtorm the place by the breach, were repulſed with great ſlaughter, and Frederick was at length compelled to raiſe the ſiege.

19
Heroic defence of Alkmaer.

Notwithſtanding theſe partial ſucceſſes, the affairs of the patriots were ſtill in a precarious ſituation. Don Louis de Requeſnes, who had ſucceeded the duke of Alva in the government, was directed to carry on the war with the utmoſt vigour. The prince of Orange had, after a long ſiege, made himſelf maſter of Middleburgh, but had ſuſtained a great loſs by the defeat and death of his brother Louis. The patriotic cauſe derived ſome advantage, however, from a mutiny which took place in the Spaniſh army, but this advantage was of a tranſient nature.

20
The States apply for aſſiſtance to Elizabeth of England,
An. 1575.

In the commencement of the year 1575, an attempt at negociation took place between the contending parties, but they could come to no terms of accommodation, and the war was continued with great virulence. Though much diſtreſſed in his finances, Philip made extraordinary efforts to cruſh the patriots, and ſucceeded ſo far, that they almoſt deſpaired of ultimate ſucceſs. In this dilemma they ſent a deputation to Queen Elizabeth of England, offering to become her ſubjects, if ſhe would

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* See *France*, N° 142.

would afford them her protection; but from political reaſons ſhe declined the offer. The diſtreſſes which Philip now experienced, and the death of his deputy Requeſnes, did more for the cauſe of the patriots than all their own exertions.

Profiting by thoſe events, in the latter end of this year they attacked and carried the citadel of Ghent; while the inhabitants of Antwerp, in revenge for having been pillaged by the Spaniſh garriſon that held the citadel, united in the common cauſe, by what was called the pacification of Ghent.

21 who at length ſends them a ſupply of money. An. 1576. A ſecond application to Queen Elizabeth met with more ſucceſs, and ſhe advanced them the ſum of 20,000l. ſterling, on condition that they would not invite the French into their territories, that they would liſten to any reaſonable terms of accommodation, and repay the loan in the courſe of the enſuing year. Agreeably to theſe conditions, a ceſſation of hoſtilities was granted to the ſtates by Don John of Auſtria, the preſent governor, and a treaty was entered into with him for diſbanding the foreign troops. The weak ſtate of the government required ſome conceſſions, and Don John acceded to the pacification of Ghent, by which moſt of the demands of the patriots were granted. The provinces of Holland and Zealand, however conceiving that by this treaty the other provinces had conceded too much, refuſed their concurrence, and hoſtilities ſoon recommenced.

22 The war renewed with freſh vigour. An. 1578. The king of Spain diſſatisfied with the conceſſions of Don John, recalled that governor, and appointed the archduke Matthias in his room, while he made additional preparations for a vigorous proſecution of the war. The ſtates-general in their turn made another application to Queen Elizabeth, and obtained from her, not only a promiſe of 100,000l. ſterling, but of a body of forces conſiſting of 5000 foot, and 1000 horſe; in return for which, the ſtates agreed to put into her poſſeſſion certain fortified towns, and to tranſport and pay the forces. Theſe ſupplies, however, Elizabeth afterwards declined ſending, though ſhe profeſſed all poſſible good will towards the provinces and their cauſe. A change of meaſures which about this time took place in the ſtates of Guelderland and Groningen, in favour of the proteſtant intereſt, contributed not a little to aid the general cauſe of the patriots, though ſeveral of the provinces were ſtill torn by inteſtine diſſenſions and jarring intereſts. At laſt the prince of Orange, perceiving that little confidence was to be placed in the unanimity of provinces rent by faction, different in religion, and divided by ambition, political maxims, and private intereſt, formed the ſcheme of more cloſely uniting the provinces of which he was governor, and cementing them with thoſe more contiguous, in which the proteſtant intereſt prevailed. Such an alliance was ſubject to fewer difficulties than attended the more general one of uniting all the provinces; it was in fact the only meaſure that could be propoſed with ſafety, and it was proſecuted with that alacrity and addreſs for which William was deſervedly celebrated.

23 Union of Utrecht, An. 1579. On the 23d of January 1579, deputies from the provinces of Holland, Zealand, Utrecht, Frieſland, Groningen, Overyſſel, and Guelderland, met at Utrecht, and ſigned the alliance ever ſince known by the name of the *Union of Utrecht*, the baſis of that commonwealth ſo renowned by the appellation of the *United Provinces*. This treaty of alliance was founded on the infraction of the pacification of Ghent ſolemnly acceded to by Philip, and the late invaſion of certain towns in Guelderland. It was not hereby intended to divide the ſeven provinces from the other ten, or to renounce the pacification of Ghent; its object was to preſerve the liberty ſtipulated in that pacification, by more vigorous operations, and united councils. The chief articles of this union were the following.

That the ſeven provinces ſhall unite themſelves in intereſt as one province, never to be ſeparated or divided by teſtament, donation, exchange, ſale, or agreement; reſerving to each particular province and city all its privileges, rights, cuſtoms, and ſtatutes. In all diſputes ariſing between either of the provinces, the reſt ſhall interpoſe only as mediators. They ſhall aſſiſt each other with life and fortune againſt every foreign attempt upon any particular province, whether to eſtabliſh ſovereignty, the Catholic religion, arbitrary meaſures, or whatever elſe may appear inconſiſtent with the liberties of the province, and the intention of the alliance. All frontier towns belonging to the United Provinces ſhall, if old, be fortified at the expence of the provinces; if new, at the joint expence of the union. That the public impoſts and duties ſhall be farmed for three months to the higheſt bidder, and employed with the king's taxes in the public ſervice. No province, city, or member of the union, ſhall contract an alliance with any foreign prince or power, without the concurrence of all the other members. That foreign powers ſhall be admitted into the alliance, only by conſent of all the contracting parties. As to religion, the provinces of Holland and Zealand ſhall act in that particular as they think adviſable: the reſt ſhall adhere to the purport of the edict publiſhed by the archduke Matthias, which preſcribed, that no man ſhould be oppreſſed on account of conſcience. All the inhabitants, from the age of 18 to 60, ſhall be trained and diſciplined to war. That peace and war ſhall be declared by the unanimous voice of all the provinces; other matters that concern the internal policy ſhall be regulated by a majority. That the ſtates ſhall be held in the uſual conſtitutional manner, and coinage ſhall be deferred to future determination. Finally, the parties agree, that the interpretation of theſe articles ſhall remain in the ſtates-general; but, in caſe of their failing to decide, in the ſtadtholder.

24 Heroic behaviour of the prince of Orange. Soon after the union of Utrecht, King Philip did all in his power to detach the prince of Orange from the new confederation. He offered to reſtore him to all his eſtates, to indemnify him for all his loſſes, and give him the firſt place in his eſteem and favour; but William was too wiſe to rely on the promiſes of a prince who had already ſhewn himſelf perfidious, and too generous to abandon a cauſe in which he had embarked from no intereſted motives. He determined to ſhare the fate of the United Provinces, and not to diſappoint the hopes which they had conceived of his conduct.

25 Succeſſes of the duke of Parma againſt the United Provinces. In the mean time the duke of Parma was doing his utmoſt to diſconcert the projects of the prince of Orange, and to reduce the provinces to their obedience to Spain. He beſieged and took the town of Marſien; inveſted Maeſtricht, and carried it after a ſiege of four months, and reduced the republican general La Noue to ſuch ſtraits, that he was glad to retreat under the cannon of Antwerp. At length the Provinces, by the advice of the prince of Orange, reſolved to ſolicit the

aſſiſtance and protection of the duke of Anjou, to whom they had formerly applied in vain, and to offer him the ſovereignty of their territories. Accordingly, in 1580, they ſolemnly renounced their allegiance to Philip, and acknowledged as their ſovereign, Francis Hercules de Vallois, duke of Alençon and Anjou; and in the following year they publiſhed an edict, entitled the abdication of Philip king of Spain, for ever excluding that monarch from any right or authority over the Netherlands.

26
Inauguration of the duke of Anjou as duke of Brabant.
An. 1582.

In the beginning of the year 1582, the duke of Anjou, who had already taken an active part in favour of his new ſubjects, and had oppoſed the duke of Parma with ſome ſucceſs, arrived in Holland from England; and in the month of February he was ſolemnly inſtalled at Antwerp as duke of Brabant. It appears, however, that the prince of Orange, though he had been the great promoter of this meaſure, and even placed the ducal coronet on the head of the new ſovereign, ſtill poſſeſſed the greateſt influence and authority in the United Provinces.

27
Aſſaſſination of the prince of Orange.
An. 1584.

When Philip of Spain found that he could not bribe the prince of Orange to his intereſts, he reſolved to uſe every method to rid himſelf of ſo dangerous an opponent. Soon after the ſigning of the union of Utrecht, Philip had proſcribed the prince, and offered a reward of 25,000 crowns to any perſon that ſhould bring him dead or alive to Madrid. The greatneſs of the reward, and a bigotted regard for the intereſts of the Catholic religion, prompted ſeveral to attempt murdering the prince of Orange. He narrowly eſcaped aſſaſſination in 1582; but, two years after, he met his unmerited fate at Delft, by the hands of one Guion, or, as he is commonly called, Balthazar Gerrard. About the ſame time the duke of Anjou died in France; and the provinces of Holland and Zealand appointed Maurice, ſon of the late prince of Orange, to be their ſtadtholder and captain-general. For an account of the actions of this great man, ſee the article *MAURICE of Naſſau.*

28
A truce for twelve years concluded with Spain.
An. 1609.

Philip II. died in 1598, and Philip III. proſecuted the war with the United Provinces with as much rancour as his predeceſſors, but with much worſe ſucceſs. The great defeat ſuſtained by the archduke Albert in 1600, and many ſubſequent diſaſters, induced the court of Madrid at length to liſten to terms of accommodation. In 1607 a ſuſpenſion of hoſtilities took place, and the year following a treaty on terms favourable to the Provinces was concluded for 12 years.

29
Renewal of hoſtilities.
An. 1621.

At the expiration of the truce, both parties prepared for a renewal of hoſtilities; but now the Spaniards fought with conſiderable diſadvantage: From a ſtrange policy, which they have ſince frequently practiſed, in their conteſts with the powers of Europe, the Dutch contrived to advance their commercial intereſts at the expence of their enemy. A very lucrative trade took place between the principal Dutch ports and thoſe of Spain, by which the Spaniards were ſupplied by their enemies even with ammunition and warlike ſtores. At the ſame time the Dutch enriched themſelves by numerous prizes taken from the Spaniards, and, in particular, gave a ſevere blow to the reſources of the court of Madrid, by capturing the flota from Mexico, a prize valued at 15,000,000 of livres.

30
Concluſion of peace.
An. 1648.

Theſe repeated loſſes of the Spaniards proved the inutility of their continuing the war againſt a people ſo determined as the Dutch. Accordingly, in 1648, they agreed to a treaty of peace, by which his Catholic majeſty renounced all right and ſovereignty over the ſtates-general of the United Provinces; and theſe provinces were henceforth declared a free and independent republic. It was alſo agreed between the contending powers, that each ſhould remain in unmoleſted poſſeſſion of thoſe places which they ſeverally held at the ſigning of the treaty.

31
Flouriſhing ſtate of the republic.

From this time to the year 1670 we meet with nothing very remarkable in the hiſtory of the United Provinces. By invariably purſuing the maxims of prudence, induſtry, and frugality, the republic had attained the higheſt pitch of grandeur. Amſterdam was become the emporium of Europe, and the richeſt city in the univerſe. The population of the Provinces, eſpecially of Holland, was much greater than at any former or ſubſequent period, though it is ſcarcely credible that, as ſome authors affirm, Holland alone ſhould then contain 3,000,000 of inhabitants. The ſtates deſpatched miniſters and conſuls to China, Siam, and Bengal; to the Great Mogul, the king of Perſia, and the khan of Tartary, the grand ſignior, the czar of Ruſſia, and the princes of Africa. They were conſidered as an important weight in the ſcale of Europe; and no treaty was concluded without the concurrence of their ambaſſadors.

32
Diſpute with France.
An. 167[illegible]

It is not ſurpriſing that the ſucceſſes of the Dutch, and the proſperous condition in which they now beheld themſelves, ſhould have rendered them rather arrogant towards the neighbouring ſtates. Louis XIV. of France had conceived himſelf affronted by a fooliſh boaſt of one of the Dutch miniſters, and he was particularly jealous of the advantage which the new republic had acquired over his ſubjects in the trade to India. The triple alliance formed about this time between England, Sweden, and the United Provinces, was an additional motive with the French king to break off all intercourſe with the Dutch, and to curb their growing power. He began by prevailing on Charles II. of England to abandon the triple alliance; a requeſt to which that worthleſs monarch, alive to nothing but his pleaſures and his avarice, readily agreed, on condition of being well paid for his treachery. Louis alſo perſuaded ſeveral of the German princes to unite their forces with his againſt the republic, and of all the Germanic body, only the elector of Brandenburg intereſted himſelf for the ſafety of the ſtates-general. The French king aſſembled an army of 100,000 men, which he divided into four columns, one commanded by himſelf in perſon, with the aſſiſtance of Marſhal Turenne; another by the prince of Condé; a third by General Crequi, and a fourth under the conduct of the duke of Luxemburg. Such an army drawing towards the frontiers could not but terrify the Dutch, now torn with civil and religious factions. The partiſans of the Orange family were for aboliſhing the perpetual edict, and raiſing William prince of Orange to the dignity enjoyed by his predeceſſors; but the De Witt faction oppoſed him violently, though they could not prevent the young prince from being choſen captain-general and high-admiral. Many hoped that William's new dignity would incline his uncle Charles II. to return to the triple alliance; but that hope was fruſtrated by the conduct of his majeſty, who, in conjunction with the Moſt Chriſtian king, declared

clared war againſt the ſtates-general on the 7th of April. A month after, the elector of Cologne and biſhop of Munſter followed the example of the two kings. The Dutch put themſelves in the beſt poſture of defence that circumſtances would admit. Maeſtricht was ſtrongly garriſoned; the prince of Orange had aſſembled an army of 25,000 men, with which he advanced to the banks of the Yſſel; and the Dutch fleet cruiſed off the mouth of the Thames, to prevent the junction of the naval forces of England and France, which amounted to 150 ſhips. All Europe watched the firſt motions of the two powerful kings, ſeconded by the beſt generals of the age.

33
Commencement of hoſtilities.

Holland could be attacked only by the Rhine or the Meuſe, and the French generals and miniſters differed by which of theſe inlets the firſt impreſſion ſhould be made. At length, after much deliberation, it was determined to attack the Dutch on both theſe ſides at the ſame time, in order the more to diſconcert their councils. The campaign began with the ſiege of Rhinberg, Veſel, Orſoi, and Rurick, four towns well fortified, and deemed the keys of Holland. Nothing could oppoſe armies ſo well appointed, led by generals ſo ſkilful and ſo experienced. The four towns were compelled to ſurrender within a few days of each other; and a ſevere defeat ſuſtained by a body of Dutch troops, in attempting to defend the paſſage of the Rhine, by the prince of Condé, ſerved ſtill more to diſhearten the troops of the ſtates-general.

34
Rapid ſucceſſes of the French.

It is almoſt incredible with what rapidity towns and fortreſſes yielded to the fortune of his majeſty's arms. The reduction of Betau, the moſt fruitful country of the United Provinces, and the ſurrender of Tolhusfert, obliged the prince of Orange to abandon the Yſſel, leſt he ſhould be attacked in the rear, and to retire to the very heart of the country, as far as Rhenen in the province of Utrecht. By this means the town of Arnheim, the forts of Knotſemborough, Voorn, St André, and Shenck, this laſt the ſtrongeſt in the Netherlands, with a variety of other forts and towns, ſurrendered as ſoon as ſummoned; and at laſt Nimeguen, a town ſtrong from the nature of the works and fortifications, and garriſoned by 8000 fighting men, including the inhabitants, was inveſted. After the citizens had for eight days exhibited ſignal proofs of courage in defence of their liberties, they were forced to yield to the ſuperior ſkill of Turenne.

35
The Dutch compelled to inundate their country.
An. 1672.

The only means by which the Dutch could arreſt the progreſs of the enemy was, to open the ſluices and inundate the country. The town of Utrecht ſet the example, which was ſoon followed by many others, and in a ſhort time Holland, Brabant, and Dutch Flanders, formed one vaſt lake, the towns riſing like iſlands in the midſt of the waters. An embaſſy was alſo ſent to the king of England, to requeſt that he would prevail on Louis to relax in the ſeverity of his attack. Charles pretended a compliance with this requeſt; but as his interference produced no effect, it is probable that he was not ſincere. In the ſpace of three months, Louis conquered the provinces of Guelderland, Overyſſel, and Utrecht, took about 50 towns and forts, and made 24,000 priſoners. The latter, however, were ſoon releaſed for a trifling ranſom. The very ſucceſſes of the conquerors tended to weaken their force, as they were compelled to leave behind them ſeveral ſtrong bodies of troops, to garriſon the captured towns. This induced the French to liſten to propoſals for a negociation, which, however, came to nothing.

Marſhal Turenne, now appointed generaliſſimo of the king's army on his majeſty's return to Paris, marched to oppoſe the elector of Brandenburg and the German general Montecuculi, who had joined their forces, and were about to paſs the Rhine. For three whole months were the elector and Montecuculi employed in abortive attempts to effect a paſſage at Mentz, Coblentz, Straſburg, and other places. This anſwered the purpoſe of making a powerful diverſion in favour of the Dutch, though they could not accompliſh their deſign of joining the prince of Orange. After repeated diſappointments, the imperial army directed its march to Weſtphalia; and Turenne followed, in order to keep the biſhop of Munſter ſteady to his engagements. For half the campaign he, with a body of 16,000 men, baffled every ſtratagem of the elector and Montecuculi, the latter the moſt renowned general of the empire, at the head of an army near triple his ſtrength. He obliged them to go into winter quarters, in a country haraſſed and exhauſted; and confirmed the biſhop of Munſter in the alliance of France, at the very time he was on terms with the emperor. He obliged the elector of Brandenburg, who took the chief command during Montecuculi's illneſs, to abandon the ſiege of Warle, took Unma Kamen, Altena, Berkemham, and ſeveral other towns and fortreſſes. By continuing his operations, he forced the elector out of his winter quarters again into the field, chaſed him from poſt to poſt, until he obliged him to quit Weſtphalia, repaſs the Weſer, and retire with precipitation into the biſhopric of Hilderſheim. After taking poſſeſſion of the elector's towns in Weſtphalia, he purſued him into the biſhopric of Hilderſheim, and at length, by mere dint of ſuperior genius, forced him to ſeek ſhelter in his hereditary dominions. All this was effected after Louvois had appointed the marſhal's army quarters in Alſace and Lorrain, amidſt the rigours of a ſevere winter, oppoſed by a ſuperior enemy, by the artifices of Louvois, and ſeconded only by his own prudence, and the affection of his troops, which he maintained in defiance of all the difficulties, hardſhips and dangers, they encountered. It was indeed ſuppoſed, that Montecuculi was prevented from giving Turenne battle by the remonſtrances of Prince Lobkovitz, the emperor's ambaſſador, influenced by the gold of Louis. Certain indeed it is, that Montecuculi's illneſs aroſe from his chagrin at ſeeing all his projects fruſtrated by the unſteady dilatory conduct of the court of Vienna. Louis's negociations diſturbed Europe no leſs than his arms. His tools and creatures ſwarmed in every court. Leopold could not be prevented from declaring in favour of Holland; but his miniſters were bought off from ſeconding the emperor's intentions. The whole Engliſh nation exclaimed againſt the alliance of their kingdom with France; but Charles ſtood in need of French gold to ſupply his extravagance and profligacy. The elector of Bavaria had indeed been compelled by Louis to retire to his capital; but it was by dint of intrigue that he was forced from his alliance with Holland, and conſtrained to make a peace with France.

While the French generals were thus carrying all before them, the combined fleets of France and England

36 Tranſactions of the Dutch at ſea.

were ſcarcely leſs ſucceſsful againſt the maritime power of the Dutch. The Engliſh ſquadron under the duke of York, uniting to that of France under D'Eſtrees, thrice engaged the Dutch fleet commanded by De Ruyter; and though neither party could boaſt of much advantage, the check ſuſtained by the Dutch admiral was of eſſential ſervice to the cauſe of the allies.

37 Change of fortune,

At length the tide of fortune began to turn in favour of the United Provinces. The court of Spain, jealous of the growing power of France, embraced the cauſe of the Dutch; and ſent an army of 10,000 men to the aſſiſtance of the prince of Orange, while the mercenary king of England was compelled by his parliament to withdraw from his unnatural alliance with the French king; and the late ill ſucceſs among the allied troops of France and Germany cooled the elector of Cologne and the biſhop of Munſter, in their friendſhip towards Louis. Thus that monarch, forſaken by his allies, was compelled to maintain ſingly a war againſt the empire, Spain, and the United Provinces. The acceſſion of the prince of Orange to the throne of England, in 1688, gave an additional blow to the French power, by bringing on an intimate connection between England and Holland.

38 and conſequent peace with France. An. 1697.

At length Louis was compelled to negociate for peace, which was concluded in 1697, by a treaty extremely favourable to the United Provinces.

39 Summary of the Dutch affairs from the end of the 17th to the beginning of the 19th century.

After the copious detail which we have elſewhere given of the military tranſactions of Europe, ſince the acceſſion of William III. to the crown of England, in which the Dutch bore a conſpicuous part, it will be here ſufficient for us to give a very brief ſummary of the principal events. After the death of William III. the ſame plan of humbling the French king, was, in conjunction with the ſtates-general, purſued by his ſucceſſor Queen Anne; and the numerous and important victories of the duke of Marlborough and Prince Eugene, led to the famous treaty of Utrecht, in 1713. See Britain, N° 340.—371. In 1747, the office of ſtadtholder was declared hereditary in the princes of Orange. In the war that took place in 1756, between France and England, a French party was formed in Holland, in oppoſition to the ſtadtholder, who favoured the alliance with England. Hence aroſe a jealouſy between the two allies, which, during the American war, increaſed to an open rupture. See Britain, N° 427, and N° 598 *et ſeq.* In 1787, ſome diſputes took place between the ſtadtholder and the ſtates-general, which induced the former to require the aſſiſtance of the king of Pruſſia. That monarch accordingly ſent an army of 18,000 Pruſſians to Amſterdam, under the duke of Brunſwick, who, in 1788, brought the whole country into ſubjection, and reinſtated the ſtadtholder in his authority. See Prussia, N° 73. In 1794 the republican armies of France having overrun the greater part of Flanders, took poſſeſſion of the Dutch provinces, which they converted into the Batavian republic. The ſtadtholder found refuge in England, and the allied armies of Germany and Pruſſia retreated into Germany. See France, N° 409, et ſeq. In the ſummer of 1799, a conſiderable Britiſh force landed in the Texel iſland, made themſelves maſters of the Dutch fleet, and, in conjunction with a body of Ruſſians, gained ſome advantages on the continent. Being oppoſed, however, by a ſuperior French force, the army was obliged to reembark, and return to England. See Britain, N° 1069. By the treaty of Amiens, concluded in March 1802, all the colonies taken by the Britiſh were reſtored to Holland, except the iſland of Ceylon. On the renewal of hoſtilities in 1803, the Batavian republic was again compelled to take an active part againſt Britain, and in conſequence again loſt the Cape of Good Hope, and ſeveral other colonies, beſides having her trade entirely ruined. Soon after the imperial diadem of France was conferred on Napoleon Bonaparte, the Dutch republic was elevated to the rank of a kingdom, and the emperor's brother, Louis, was appointed the firſt king of Holland.

With reſpect to the preſent ſtate of this unfortunate country, we know very little that can be relied on. The people are evidently in a ſtate of complete ſubjection to the French government; and though the late rumours of their avowed annexation to the empire of France may be premature, there can be little doubt of their being eventually confirmed.

40 Population of the United Provinces.

According to the ſtatiſtical table given in N° 2, the population of the United Provinces in the year 1796, appears to amount to 1,880.469 individuals; though it is generally eſtimated at about 2,000,000. Suppoſing this latter number to be correct, and that the area of the Dutch territory comprehends 10,000 ſquare miles, there will be 200 individuals to each ſquare mile; a proportion exceeding any thing that is to be found in any other part of Europe.

41 Conſtitution and government.

In the late republic of Holland, previous to the French revolution, the ſtates-general formed the great council of the nation. That aſſembly was formed by deputies from the provincial ſtates, and was inveſted with the ſupreme legiſlative power. It could not, however, make peace or war, form new alliances, or levy taxes, without the conſent of the provincial ſtates, nor could theſe determine any point of importance, without the conſent of each of the cities that had a voice in their aſſembly. The ſtadtholder exerciſed a conſiderable part of the executive power, though in later times his power became very limited. The grand penſionary was properly a miniſter or ſervant of the province; and though he poſſeſſed great influence, being a perpetual member of the ſtates-general, and of the ſecret committee, he was conſidered as inferior in rank to all the deputies.

The leading features in the conſtitution of the kingdom of Holland are, the guarantee of the payment of the public debt; the free and unqualified exerciſe of religion; the predominant authority veſted in the king; the eſtabliſhment of the Salique law, excluding females from the throne; the declaration that the minority of any future king ſhall expire on his attaining his 18th year; that only natives ſhall be eligible to any offices of ſtate, excluſive of thoſe immediately appertaining to the king's houſehold; that the yearly revenue of the king ſhall be 2,000,000 florins, and that the royal reſidences ſhall be the palaces of the Hague, in the Wood, and at Soeſt dyke. The council of ſtate is to conſiſt of 13 members; the general government of the kingdom is to be committed to four miniſters of ſtate; and the legiſlative body is to be compoſed of 38 members choſen for five years *.

42 Revenues.

The revenues of the United Provinces aroſe principally from taxes impoſed on each province and city, according

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* *Playfair's Geography*, vol. ii.

cording to their ability. Theſe conſiſted chiefly of a general exciſe, a land tax, a poll-tax, and hearth money; and are ſuppoſed to have amounted to 3,000,000l. ſterling.

43 Military ſtrength. Before the French revolution, the Dutch maintained a peace eſtabliſhment of 30,000 men, which in war was augmented to above 50,000, chiefly by mercenary troops from Germany. Their naval eſtabliſhment was highly reſpectable; and at the end of the 17th century it exceeded that of any other maritime power in Europe. Before the late war they could muſter 40 ſail of the line, 40 frigates, and 10 cutters. Since the celebrated engagement off the Dogger Bank during the American war, the Dutch have been ſcarcely able to cope with the Engliſh at ſea; and the victory off Camperdown in October 1797, with the ſubſequent loſs of the Texel fleet in 1799, proved the deathblow to the naval power of Holland.

44 Religion. Before the late change of government, the eſtabliſhed religion of Holland was Preſbyterianiſm, according to the doctrines of Calvin; though all ſects of Chriſtians were tolerated. The church was governed by conſiſtories, claſſes, and ſynods, from which there was an appeal to one great national ſynod, ſubject to the controul of the ſtates-general.

45 Language and literature. The Dutch language is a dialect of the German, and in many reſpects bears a conſiderable reſemblance to the Old Engliſh and Lowland Scotch. The literature of the United Provinces has long been reſpectable; and the univerſities of Leyden, Utrecht, Groningen, Harderwyck, and Franeker, have produced many eminent and celebrated men in almoſt every department of ſcience. Grotius, Eraſmus, Boerhaave, Leuwenhoeck, Swammerdam, Græviuſ, Burrman, Hooguween, &c. are names mentioned with admiration and reſpect in the annals of literature.

46 Manufactures. The Dutch manufactures conſiſt principally of fine linens, earthen ware, chiefly manufactured at Delft, eſpecially white and painted tyles, tobacco-pipes, borax, oil, ſtarch, paper, leather, woollen and cotton cloths, ſnuff, tobacco, and gin.

47 Commerce. The commerce of the Dutch was formerly more extenſive than that of any other country in Europe. They carried on a trade with every quarter of the globe, and in particular their Eaſt India Company was perhaps the richeſt ſociety of merchants in the world. Holland was almoſt the excluſive centre of the ſpice trade; and the extenſive fiſheries on the coaſt of Greenland and in the North ſea, ſupplied the greater part of Europe with whale oil and herrings. Beſides this external commerce, they carried on a conſiderable inland traffic with the interior of Germany, from which they brought immenſe quantities of timber. Vaſt rafts of trees, many hundred feet in length, ſet out annually from the foreſts of Andernach, and other places on the Rhine, and proceeding down the river under the direction of a great body of labourers, that formed a village of huts on the ſurface of the raft, ſailed down the Rhine and the Waal to Dort, where the timber was diſpoſed of, and where one raft has been ſold for 30,000l. ſterling. All the foreign trade of Holland may now be conſidered as annihilated, but the inland traffic in wood and ſpirits ſtill continues.

The inland commerce of the United Provinces is greatly promoted by the facility of conveyance from one part of the country to another, by means of the numerous canals.

48 Character of the Dutch. The Dutch are, by conſtitution, a cool, or rather phlegmatic people, laborious, patient, obſtinate, and perſevering. When ſtimulated by any predominant paſſion, as avarice, or formerly love of liberty, they are capable ef great exertions. Economy and order in the management of their pecuniary concerns are common among all claſſes, with whom it is an eſtabliſhed maxim to ſpend leſs than their income. Intereſt and love of money regulate all their actions, and appear to ſupplant in their breaſts every noble and generous feeling. Theſe prominent features in the national character are, of courſe, modified by the rank or ſituation of the different orders in ſociety. The higher ranks value themſelves much on their diſtinctions, are reſerved to ſtrangers, but affable and obliging to thoſe with whom they have had an opportunity of becoming acquainted; friendly, candid, and ſincere. The mercantile men and traders are, in general, fair and honeſt in their tranſactions; though their natural thirſt of gain ſometimes tempts them to deceive and overreach their cuſtomers. The lower ranks are ignorant, dull, and ſlow of apprehenſion, but open to conviction, and patient of fatigue and labour.

49 Manners and cuſtoms. Dreſs, among the Dutch, is regulated leſs by faſhion, than by an attention to climate and ſeaſon. The moiſture and inconſtancy of theſe require a greater quantity of clothing than is found neceſſary in other countries under the ſame latitude; and, among the ordinary claſſes, broad hats, large breeches and thick boots and ſhoes, are ſtill almoſt univerſal. Moſt of the women wear hats with low crowns and very broad rims, with jerkins and ſhort petticoats; and, what appears exceedingly ridiculous to ſtrangers, the boys and girls wear the ſame dreſs as the men and women.

A cloſe attention to regularity and neatneſs in the ſtreets and the interior of the houſes prevails throughout the United Provinces, but is moſt conſpicuous in North Holland. This was at firſt rendered neceſſary by the nature of the climate, to prevent ruſt and mouldineſs from deſtroying their utenſils and furniture, and has ſince become a habit, conducive at once to comfort and to health. The manner of living in Holland was, till of late, not a little groſs. Their diet conſiſted much of high-ſeaſoned and ſalted meats, butter, cheeſe, and ſpirituous liquors. In no country was gormandizing reduced more to a ſyſtem. Convivial entertainments were extremely frequent; and the interval between the more ſubſtantial meals of dinner, tea, and ſupper, were filled up with cakes, fruits, jellies, and other light things; not to mention ſmoking and drinking, which ſupplied the place of converſation (c). If we may rely on the report of a late writer on the ſtatiſtics of Holland *, the ſtyle of living is now much changed, though not much improved.

* *Metelerkamp.* See *Month. Mag. for Nov.* 1807.

(c) We muſt admit, that, in ſo moiſt and cold a climate, a full and generous diet may be ſafe if not neceſſary; but the Dutch, like many of our own countrymen, abſurdly carried the ſame ſyſtem into their tropical colonies.

improved. Animal food is become extremely rare, and its place is ſupplied by a greater proportion of gin, tea, and coffee. The prevailing amuſements in winter are dramatic entertainments and ſkaiting, in which latter they are exceedingly expert.

The Dutch taſte for formal gardens, ſtraight walks, trees and hedges clipped into fantaſtic ſhapes, and flower roots, has long been proverbial, and has been treated with more contempt and ridicule than it deſerves. At worſt, theſe are but harmleſs propenſities; and, if indulged in moderation, are well ſuited to relieve the ſameneſs and inactivity of a retirement from the buſy ſcenes of trade and commerce.

UNITY, in *Poetry*. There are three unities to be obſerved, viz. the unity of action, that of time, and that of place. In the epic poem, the great, and almoſt the only, unity, is that of the action. Some regard indeed ought to be had to that of time; for that of place there is no room. The unity of character is not reckoned among the unities. See POETRY, Part II. Sect. 3.

UNIVERSAL, ſomething that is common to many things; or it is one thing belonging to many or all things.

UNIVERSE, a collective name, ſignifying the whole world; or the aſſemblage of heaven and earth, with all things therein. See ASTRONOMY and GEOGRAPHY.

UNIVERSITY, is the name of a corporation formed for the education of youth in the liberal arts and ſciences, and authorized to admit ſuch as have ſtudied in it, to certain *degrees* in different faculties, which not only ſerve as certificates of proficiency in ſcience, but alſo confer on thoſe who obtain them conſiderable privileges within the univerſity, as well as ſome rank in the ſtate without it. Univerſities generally comprehended within them one or more colleges: but this is not always the caſe; for the univerſity of St Andrew's was in being before either of its colleges was founded, and it would continue in being, with all its privileges, though both its colleges were levelled with the duſt.

In every univerſity with which we are acquainted, there are four faculties, viz. *Theology*, *Law*, *Phyſic*, and the *Arts and Sciences*, comprehending mathematics, natural and moral philoſophy, &c.: and in Oxford, Cambridge, and ſome other univerſities, *Muſic* is conſidered as a fifth faculty. In each of theſe there are two degrees, thoſe of *Bachelor* and *Doctor*; for though in the univerſities of Great Britain and Ireland we have no ſuch degree as *Doctor in Arts and Sciences*, our *Maſter of Arts* anſwers to the degree of *Doctor in Philoſophy*, which is conferred by many of the univerſities on the continent.

Univerſities in their preſent form, and with their preſent privileges, are inſtitutions comparatively modern. They ſprang from the convents of regular clergy, or from the chapters of cathedrals in the church of Rome, where young men were educated for holy orders, in that dark period when the clergy poſſeſſed all the little erudition which was left in Europe. Theſe convents were ſeminaries of learning probably from their firſt inſtitution; and we know with certainty, that in Old Aberdeen there was a monaſtery in which youth were inſtructed in *theology*, the *canon law*, and the *ſchool philoſophy*, at leaſt 200 years before the univerſity and King's College were founded. The ſame was doubtleſs the caſe in Oxford and Cambridge, and probably in every town in Europe, where there is now a univerſity which has any claim to be called ancient; for it was not till the more eminent of the laity began to ſee the importance of literature and ſcience, that univerſities diſtinct from convents were founded, with the privilege of admitting to degrees, which conferred ſome rank in civil ſociety. Theſe univerſities have long been conſidered as lay corporations; but as a proof that they had the eccleſiaſtical origin which we have aſſigned to them, it will be ſufficient to obſerve, that the pope arrogated to himſelf the right of veſting them with all their privileges; and that, prior to the Reformation, every univerſity in Europe conferred its degrees in all the faculties by authority derived from a papal bull.

It is perhaps no improbable conjecture, that the church of Rome derived her idea of academical honours from the Jews, among whom literary diſtinctions extremely ſimilar ſubſiſted before the nativity of our Saviour. Among them, the young ſtudent, with reſpect to his learning, was called a *diſciple*; from his minority a *junior*; and the *choſen* or *elected*, on account of his election into the number of diſciples. When he had made ſome progreſs in knowledge, and was deemed worthy of a degree, he was by impoſition of hands made חבר, *a companion* to *a Rabbi*, the perſon who officiates uſing this form, *I aſſociate thee*, or, *Be thou aſſociated*; and as ſoon afterwards as he was thought worthy to teach others, the *aſſociate* was raiſed to the rank of *Rabbi*. Whether this proceſs ſuggeſted the idea or not, it has certainly ſome reſemblance to that by which a young man in our univerſities paſſes through the degree of *Bachelor* to that of *Maſter of Arts* or *Doctor*.

The moſt ancient univerſities in Europe are thoſe of OXFORD, CAMBRIDGE, PARIS, SALAMANCA, and BOLOGNA; and in the two Engliſh univerſities, the firſt colleges are thoſe of *Univerſity*, *Baliol*, and *Merton*, in the former, and *St Peter's* in the latter. Oxford and Cambridge, however, were univerſities, or, as they were then called, *ſtudies*, ſome hundreds of years before colleges or ſchools were built in them; for the former flouriſhed as a ſeminary of learning in the reign of Alfred the Great, and the other, could we believe its partial partizans, at a period ſtill earlier. The univerſities of Scotland are four, ST ANDREWS, GLASGOW, ABERDEEN, and EDINBURGH. In Ireland there is but one univerſity, viz. that of DUBLIN, founded by Queen Elizabeth, and very richly endowed.

An idle controverſy has been agitated, whether the conſtitution of the Engliſh or of the Scotch univerſities be beſt adapted to anſwer the ends of their inſtitution; and, as might be expected, it has been differently decided, according to the partialities of thoſe who have written on the ſubject. Were we to hazard our own opinion, we ſhould ſay, that each has its advantages and diſadvantages; and that while the Engliſh univerſities, aided

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The account given by a late traveller (ſee Barrow's *Voyage to Cochin-China*) of the luxurious mode of living at Batavia, affords a melancholy, but accurate picture of Dutch gluttony.

aided by their great ſchools, to which we have nothing that can be compared, are unqueſtionably fitted to carry their young members fartheſt in the knowledge of the learned languages, the mode of teaching in our own univerſities is better adapted to the promotion of arts and ſciences, and the communication of that knowledge which is of moſt importance in active life.

UNIVERSITY-Courts, in England. The two univerſities enjoy the ſole juriſdiction, in excluſion of the king's courts, over all civil actions and ſuits whatſoever, where a ſcholar or privileged perſon is one of the parties; excepting in ſuch caſes where the right of freehold is concerned. And then by the univerſity charter they are at liberty to try and determine, either according to the common law of the land, or according to their own local cuſtoms, at their diſcretion; which has generally led them to carry on their proceſs in a courſe much conformed to the civil law.

This privilege, ſo far as it relates to civil cauſes, is exerciſed at Oxford in the chancellor's court; the judge of which is the vice-chancellor, his deputy, or aſſeſſor. From his ſentence an appeal lies to delegates appointed by the congregation; from thence to other delegates of the houſe of convocation; and if they all three concur in the ſame ſentence, it is final, at leaſt by the ſtatutes of the univerſity, according to the rule of the civil law. But if there be any diſcordance or variation in any of the three ſentences, an appeal lies in the laſt reſort to judges delegates appointed by the crown, under the great ſeal in chancery.

As to the juriſdiction of the univerſity courts in criminal matters, the chancellor's court at Oxford, and probably alſo that of Cambridge, hath authority to try all offences or miſdemeanors under the degree of treaſon, felony, or mayhem; and the trial of treaſon, felony, and mayhem, by a particular charter, is committed to the univerſity juriſdiction in another court, namely, the court of the lord high ſteward of the univerſity.

The proceſs of the trial is this. The high ſteward iſſues one precept to the ſheriff of the county, who thereupon returns a panel of 18 freeholders; and another precept to the bedells of the univerſity, who thereupon return a panel of 18 matriculated laymen, *laicos privilegio univerſitatis gaudentes*: and by a jury formed *de medietate*, half of freeholders and half matriculated perſons, is the indictment to be tried; and that in the guildhall of the city of Oxford. And if execution be neceſſary to be awarded in conſequence of finding the party guilty, the ſheriff of the county muſt execute the univerſity proceſs; to which he is annually bound by an oath.

VOCABULARY, in *Grammar*, denotes the collection of the words of a language, with their ſignifications, otherwiſe called a *dictionary*, *lexicon*, or *nomenclature*. See DICTIONARY.

A vocabulary is properly a ſmaller kind of dictionary, which does not enter ſo minutely into the origin and different acceptations of words.

VOCAL, ſomething that relates to the voice or ſpeech; thus vocal muſic is that ſet to words, eſpecially verſes, and to be performed by the voice; in contradiſtinction to inſtrumental muſic, compoſed only for inſtruments, without ſinging.

VOCATIVE, in *Grammar*, the fifth ſtate or caſe of nouns. See GRAMMAR.

VOETIUS or VOET, GISBERT, an eminent divine of the 16th century, was profeſſor of divinity and the Oriental tongues at Utrecht, where he was alſo miniſter. He aſſiſted at the ſynod of Dort; and died in 1676, aged 87. He wrote a great number of works; and was the declared enemy of Des Cartes and his philoſophy. His followers are called *Voetians*. Voetius had two ſons, *Daniel* and *Paul*, both authors. *John Voetius*, the ſon of Paul, was doctor and profeſſor of law at Herborn, and wrote a commentary on the Pandects,

VOICE, a ſound produced in the throat and mouth of an animal, by peculiar organs.

Voices are either articulate or inarticulate. Articulate voices are thoſe whereof ſeveral conſpire together to form ſome aſſemblage or little ſyſtem of ſounds: ſuch are the voices expreſſing the letters of an alphabet, numbers of which joined together form words. Inarticulate voices are ſuch as are not organized, or aſſembled into words; ſuch is the barking of dogs, the braying of aſſes, the hiſſing of ſerpents, the ſinging of birds, &c.

For a deſcription of the organs of the voice, ſee ANATOMY; ſee alſo PHYSIOLOGY *Index*.

VOICE, in *Grammar*, a circumſtance in verbs, whereby they come to be conſidered as either active or paſſive, *i. e.* either expreſſing an action impreſſed on another ſubject, as, *I beat*; or receiving it from another, as, *I am beaten*. See GRAMMAR.

VOICE, in matters of election, denotes a vote or ſuffrage.

VOICE, in *Oratory*. See DECLAMATION; READING, N° 5.; and ORATORY, N° 129—131.

VOLANT, in *Heraldry*, is when a bird, in a coat of arms, is drawn flying, or having its wings ſpread out.

VOLATILE, in *Phyſics*, ſomething that is eaſily diſſipated by fire or heat.

VOLATILE Alkali. See AMMONIA, CHEMISTRY *Index*.

VOLATILISATION, the art of rendering fixed bodies volatile, or of reſolving them by fire into a vapour.

VOLCANO, a name given to burning mountains, or to vents for ſubterraneous fires. See GEOLOGY *Index*, ÆTNA, HECLA, &c.

VOLERY, a bird-cage, of ſuch a ſize that the birds have room to fly up and down in it.

VOLGA, the largeſt river in Europe, derives its origin from two ſmall lakes in the foreſt of Volkonſki about 80 miles from Tver, a town in Ruſſia. It is navigable a few miles above that town. This noble river waters ſome of the fineſt provinces in the Ruſſian empire. and at laſt falls into the Caſpian ſea by ſeveral mouths, below Aſtracan.

The Volga is ſubject to annual inundation. In the year 1774, the inundations exceeded the loweſt watermark by nearly 40 feet, ſince which period they have been rather on the decline; for in 1775, they roſe only to 39 feet 2 inches above that mark; in 1782, they roſe to 26 feet; in 1785, to 25 feet 2 inches; and in the year 1791, their height was the ſame. Pallas is of opinion that this phenomenon may have originated from the diminiſhed quantity of ſnow and rain which had fallen in the higher countries; from the greater evaporation of the Caſpian ſea, and the gradual extenſion of the different mouths of the river, or perhaps from the joint operation of all theſe cauſes.

VOLITION, the act of willing. See METAPHYSICS.

VOLLEY, a military ſalute, made by diſcharging a great number of fire arms at the ſame time.

VOLONES, in Roman antiquity, ſlaves who in the Punic war voluntarily offered their ſervice to the ſtate, which is the reaſon of the appellation; upon which they were admitted to citizenſhip, as none but freemen could be ſoldiers.

VOLT, in the manege, a round or circular tread; and hence, by the phraſe *to make volts*, is underſtood a gate of two treads, made by a horſe going ſidewiſe round a centre, in ſuch a manner that theſe two treads make parallel tracks; one larger, made by the fore-feet, and another ſmaller made by the hind-feet; the croup approaching towards the centre, and the ſhoulders bearing out.

VOLTAIRE, FRANCIS AROUET DE, a celebrated French author, was born at Paris, February 20. 1694. His father, Francis Arouet, was *ancien notaire au Chatelet*, and treaſurer of the chamber of accounts; his mother, Mary-Margaret Draumart. At the birth of this extraordinary man, who lived to the age of 85 years and ſome months, there was little probability of his being reared, and for a conſiderable time he continued remarkably feeble. In his earlieſt years he diſplayed a ready wit and a ſprightly imagination; and, as he ſaid of himſelf made verſes before he was out of his cradle. He was educated, under Father Poré, in the college of Louis the Great; and ſuch was his proficiency, that many of his eſſays are now exiſting, which, though written when he was between 12 and 14, ſhow no marks of infancy. The famous Ninon de l'Enclos, to whom this ingenious boy was introduced, left him a legacy of 2000 livres to buy him a library. Having been ſent to the equity ſchools on his quiting college, he was ſo diſguſted with the dryneſs of the law, that he devoted himſelf entirely to the muſes. He was admitted into the company of the abbe Cheaulieu, the marquis de la Fare, the duke de Sully, the grand prior of Vendome, marſhal Villars, and the chevalier du Bouillon; and caught from them that eaſy taſte and delicate humour which diſtinguiſhed the court of Louis XIV. Voltaire had early imbibed a turn for ſatire; and, for ſome philippics againſt the government, was impriſoned almoſt a year in the Baſtile. He had before this period produced the tragedy of *Oedipus*, which was repreſented in 1718 with great ſucceſs; and the duke of Orleans happening to ſee it performed, was ſo delighted, that he obtained his releaſe from priſon. The poet waiting on the duke to return thanks; "Be wiſe (ſaid the duke), and I will take care of you." "I am infinitely obliged (replied the young man); but I intreat your royal highneſs not to trouble yourſelf any farther about my lodging or board."

He began his *Henriade* before he was 18. Having one day read ſeveral cantos of this poem when on a viſit to his intimate friend, the young preſident de Maiſons, he was ſo teaſed with objections, that he loſt patience, and threw his manuſcript into the fire. The preſident Henaut with difficulty reſcued it. "Remember (ſaid Mr Henaut to him, in one of his letters) it was I that ſaved the Henriade, and that it coſt me a handſome pair of ruffles." Some years after, ſeveral copies of this poem having got abroad, while it was only a ſketch, an edition of it was publiſhed, with many chaſms, under the title of *The League*. Inſtead of fame and friends, the author gained only enemies and mortification, by this firſt edition. The bigots took fire at it, and the poet was conſidered as highly criminal for praiſing Admiral Coligny and Queen Elizabeth. Endeavours were even uſed to get the piece ſuppreſſed; but this ſtrange deſign proved abortive. His chagrin, on on this occaſion, firſt inſpired him with the thought of viſiting England, in order to finiſh the work, and republiſh it in a land of liberty. He was right; for King George I. and more particularly the princeſs of Wales, afterwards queen of England, raiſed an immenſe ſubſcription for him. Their liberality laid the foundation of his fortune; for on his return to France in 1728, he put his money into a lottery eſtabliſhed by M. Desfortes, comptroller-general of the finances. The adventurers received a rent charge on the *Hotel-de Ville* for their tickets; and the prizes were paid in ready money; ſo that if a ſociety had taken all the tickets, it would have gained a million of livres. He joined with a numerous company of adventurers, and was fortunate.

His *Lettres Philoſophiques*, abounding in bold expreſſions and indecent witticiſms againſt religion, having been burnt by a decree of the parliament of Paris, and a warrant being iſſued for apprehending the author in 1733, Voltaire prudently withdrew; and was ſheltered by the marchioneſs du Chatelet, in her caſtle of Cirey, on the borders of Champagne and Lorraine, who entered with him on the ſtudy of the ſyſtem of Leibnitz, and the Principia of Newton. A gallery was built, in which Voltaire formed a good collection of natural hiſtory, and made an infinite number of experiments on light and electricity. He laboured in the mean time on his Elements of the Newtonian Philoſophy, then totally unknown in France, and which the numerous admirers of Des Cartes were little deſirous ſhould be known. In the midſt of theſe philoſophic purſuits he produced the tragedy of *Alzira*. He was now in the meridian of his age and genius, as was evident from the tragedy of *Mahomet*, firſt acted in 1741; but it was repreſented to the procureur-general as a performance offenſive to religion; and the author, by order of Cardinal Fleury, withdrew it from the ſtage. *Merope*, played two years after, 1743, gave an idea of a ſpecies of tragedy, of which few models had exiſted. It was at the repreſentation of this tragedy, that the pit and boxes were clamorous for a ſight of the author; yet it was ſeverely criticiſed when it came from the preſs. He now became a favourite at court, through the intereſt of Madame d'Etiole, afterwards marchioneſs of Pompadour. He was appointed a gentleman of the bed-chamber in ordinary, and hiſtoriographer of France. He had frequently attempted to gain admittance into the Academy of Sciences, but could not obtain his wiſh till 1746, when he was the firſt who broke though the abſurd cuſtom of filling an inaugural ſpeech with the fulſome adulation of Richelieu; an example ſoon followed by other academicians. From the ſatires occaſioned by this innovation he felt ſo much uneaſineſs, that he was glad to retire with the marchioneſs du Chatelet to Luneville, in the neighbourhood of King Staniſlaus. The marchioneſs dying in 1749, Voltaire returned to Paris, where his ſtay was but ſhort. The king of Pruſſia now gave Voltaire an invitation to live with him, which he accepted towards the end of Auguſt 1750. On his arrival at Berlin, he was immediately preſented with the *Order of Merit*, the *key of chamberlain*, and a *penſion* of 20,000 livres. From the particular reſpect that was paid to him, his time was now ſpent in the moſt agreeable manner; his apartments were under thoſe of the king, whom he was allowed to viſit at ſtated hours, to read with him the beſt works of either ancient or modern authors, and to aſſiſt his majeſty in the literary productions by which he relieved the cares of government. But a diſpute which aroſe between him and Maupertuis ſoon brought on his diſgrace. Maupertuis was at ſome pains to have it reported at court, that one day while General Manſtein happened to be in the apartments of M. de Voltaire, who was then tranſlating into French the Memoirs of Ruſſia, compoſed by that officer, the king, in his uſual manner, ſent a copy of verſes to be examined, when Voltaire ſaid to Manſtein, "Let us leave off for the preſent, my friend; you ſee the king has ſent me his dirty linen to waſh, I will waſh your's another time." A ſingle word is ſometimes ſufficient to ruin a man at court; Maupertuis imputed ſuch a word to Voltaire. and ſucceeded. It was about this very time that Maupertuis publiſhed his very ſtrange Philoſophical Letters; and M. de Voltaire did not fail to heighten, with his utmoſt powers of raillery, every thing which he found, or could make, ridiculous, in the projects of M. Maupertuis, who was careful to unite his own cauſe with that of the king; Voltaire was conſidered as having failed in reſpect to his majeſty; and therefore, in the moſt reſpectful manner, he returned to the king his chamberlain's key, and the croſs of his Order of Merit: accompanied with four lines of verſe; in which he, with great delicacy, compares his ſituation to that of a jealous lover, who ſends back the picture of his miſtreſs. The king returned the key and the ribbon; but they were not followed by an immediate reconciliation. Voltaire ſet out to pay a viſit to her highneſs the ducheſs of Gotha, who honoured him with her friendſhip as long as ſhe lived. While he remained at Gotha, Maupertuis employed all his batteries againſt him: Voltaire was arreſted by the king's orders, but afterwards releaſed.

He now ſettled near Geneva; but afterward being obliged to quit that republic, he purchaſed the caſtle of Ferney in France, about a league from the lake of Geneva. It was here that he undertook the defence of the celebrated family of Calas; and it was not long before he had a ſecond opportunity of vindicating the innocence of another condemned family of the name of *Sirven*. It is ſomewhat remarkable, that in the year 1774, he had the third time a ſingular opportunity of employing that ſame zeal which he had the good fortune to diſplay in the fatal cataſtrophe of the families of Calas and Sirven.

In this retreat M. Voltaire continued long to enjoy the pleaſures of a rural life, accompanied with the admiration of a vaſt number of wits and philoſophers throughout all Europe. Wearied at length, however, with his ſituation, or yielding to the importunities of friends, he came to Paris about the beginning of the year 1778. where he wrote a new tragedy called *Irene*. By this time his underſtanding ſeems to have been impaired, either through the infirmities of age, or continued intoxication by the flattery of others; and he ridiculouſly ſuffered himſelf to be crowned in public with laurel, in teſtimony of his great poetical merit. He did not long ſurvive this farce: for having overheated himſelf with receiving viſits, and exhauſted his ſpirits by ſupplying a perpetual fund of converſation, he was firſt ſeized with a ſpitting of blood; and at laſt becoming reſtleſs in the night-time, he was obliged to uſe a ſoporific medicine. Of this he unluckily one night took ſo large a doſe, that he ſlept 36 hours, and expired a very ſhort time after awakening from it.

VOLUME, in matters of literature, a book or writing of a juſt bulk to be bound by itſelf. The name is derived from the Latin *volvere*, "to roll up;" the ancient manner of making up books being in rolls of bark or parchment. See BOOK.

VOLUNTARY, in *Muſic*, a piece played by a muſician extempore, according to his fancy. This is often uſed before he begins to ſet himſelf to play any particular compoſition, to try the inſtrument, and to lead him into the key of the piece he intends to perform.

VOLUNTEERS, perſons who, of their own accord, for the ſervice of the prince or ſtate, ſerve in the army without being enliſted, to gain honour and preferment.

VOLVOX, a genus of animals belonging to the *vermes infuſoria*. See HELMINTHOLOGY *Index*.

VOLUSENUS. See WILSON.

VOLUTA, a genus of ſhell-fiſh. See CONCHOLOGY *Index*.

VOLUTE, in *Architecture*, a kind of ſpiral ſcroll uſed in Ionic and Compoſite capitals, whereof it makes the principal characteriſtic and ornament.

VOMICA, in *Medicine*, an abſceſs of the lungs. See MEDICINE, N° 186.

Nux VOMICA, in *Pharmacy*. See MATERIA MEDICA *Index*.

VOMIT. See EMETIC, MATERIA MEDICA *Index*.

VOMITING, a retrograde ſpaſmodic motion of the muſcular fibres of the œſophagus, ſtomach, and inteſtines, attended with ſtrong convulſions of the muſcles of the abdomen and diaphragm; which when gentle, create a nauſea; when violent, a vomiting.

VOORN, one of the iſlands of Holland, bounded by the river Maes, which divides it from the continent and the iſland of Iſſemunde, on the north; by the ſea called *Bies-boſch*, on the eaſt; by another branch of the Maes, which divides it from the iſlands of Goree and Overflackee, on the ſouth; and by the German ſea on the weſt; being about 24 miles long, and five broad.

VORTEX, in *Meteorology*, a whirlwind, or ſudden, rapid, and violent motion of the air in circles; or that motion of the water called an *eddy* or whirlpool.

VORTEX, in the Carteſian philoſophy, is a ſyſtem or collection of particles of matter moving the ſame way, and round the ſame axis.

VORTICELLA, an animalcule. See MICROSCOPE.

VOSSIUS, JOHN GERARD, a moſt learned and laborious writer of the 17th century, was of a conſiderable family in the Netherlands; and was born in 1577, in the Palatinate, near Heidelberg, at a place where his father, John Voſſius, was miniſter. He was made director of the college of Dort, and afterwards profeſſor of eloquence and chronology at Leyden, from whence he was called in 1633 to Amſterdam, to fill the chair of profeſſor of hiſtory. He died in 1649.

VOTE, the ſuffrage or reſolve of each of the members of an aſſembly, where any affair is to be carried by a majority; but more particularly uſed for the reſolves of the members of either houſe of parliament.

VOTIVE MEDALS, thoſe on which are expreſſed the vows of the people for the emperors or empreſſes. See MEDAL.

VOW, a ſolemn and religious promiſe or oath. See OATH.

The uſe of vows is found in moſt religions. They make up a conſiderable part ef the Pagan worſhip, being made either in conſequence of ſome deliverance, under ſome preſſing neceſſity, or for the ſucceſs of ſome enterpriſe. Among the Jews, all vows were to be voluntary, and made by perſons wholly in their own power; and if ſuch perſon made a vow in any thing lawful and poſſible, he was obliged to fulfil it. If he appointed no particular time for accompliſhing his vow, he was bound to do it inſtantly, leſt by delay he ſhould prove leſs able, or be unwilling, to execute his promiſe. Among the Romaniſts, a perſon is conſtituted a religious by taking three vows; that of poverty, chaſtity, and obedience.

VOWS, among the Romans, ſignified ſacrifices, offerings, preſents, and prayers made for the Cæſars, and emperors, particularly for their proſperity and the continuance of their empire. Theſe were at firſt made every five years, then every 15, and afterwards every 20, and were called *quinquennalia*, *decennalia*, and *vincennalia*.

VOWEL, in *Grammar*, a letter which affords a complete ſound of itſelf, or a letter ſo ſimple as only to need a bare opening of the mouth to make it heard, and to form a diſtinct voice. The vowels are ſix in number, viz. A, E, I, O, U, Y.

VOWEL, *John*. See HOOKER.

UPHOLSTER, UPHOLSTERER, or *Upholder*, a tradeſman that makes beds, and all ſorts of furniture thereunto belonging, &c.

UPLAND, denotes high ground, or, as ſome call it, *terra firma*, by which it ſtands oppoſed to ſuch as is mooriſh, marſhy, or low.

UPLAND, a province of Sweden, bounded on the north-eaſt by the Baltic ſea, on the ſouth by the ſea of Sudermania, and on the weſt by Weſtmania and Geſtricia, from which it is ſeparated by the river Dela. It is about 70 miles in length and 45 in breadth, and contains mines of iron and lead. Stockholm is the capital.

UPSAL, a rich and conſiderable city of Sweden, in Upland, with a famous univerſity, and an archbiſhop's ſee. The town is pretty large, and as ſtraight as a line; but moſt of the houſes are of wood, covered with birch bark, with turf on the top. On an eminence, to the ſouth of the town, is a ruined caſtle. Thoſe that view the town from hence would take it to be a garden, whoſe ſtreets repreſent the alleys; and the houſes, which are covered with turf, the graſs-plots. It was formerly the reſidence of the kings, and is now the uſual place where they are crowned. It is ſeated on the river Sala, over which there are two bridges. It is 26 miles north-weſt of Stockholm. E. Long. 17. 48. N. Lat. 59. 52.

UPUPA, a genus of birds belonging to the order of *picæ*. See ORNITHOLOGY *Index*.

UR, in *Ancient Geography*, a citadel of Meſopotamia, ſituated between the Tigris and Niſibis; taken by ſome for Ur of the Chaldees, the reſidence of Abraham. What ſeems to confirm this is, that from Ur to Haran, the other reſidence of the patriarch, the road lies directly for Paleſtine. And it is no objection that Ur is ſaid to be in Meſopotamia; becauſe the parts next the Tigris were occupied by the Chaldeans, as ſeems to be confirmed from Acts vii. 2, 4. It is called *Orche*, in Strabo; *Orchoe*, in Ptolemy.

URALIAN CHAIN, a range of mountains which form part of the boundaries of Aſia, and anciently known by the name of *Riphæi Montes*. See *RIPHÆI Montes*, and GEOLOGY *Index*.

URANIA, in fabulous hiſtory, one of the nine Muſes, was ſuppoſed to preſide over aſtronomy. She is commonly repreſented in an azure robe, crowned with ſtars, and ſupporting a large globe with both hands.

URANIUM, one of the lately diſcovered metals. See CHEMISTRY and MINERALOGY *Index*.

URANOSCOPUS, a genus of fiſhes belonging to the order of *jugulares*. See ICHTHYOLOGY *Index*.

RAPHAEL D'URBINO. See RAPHAEL.

URCHIN, or HEDGEHOG. See ERINACEUS, MAMMALIA *Index*.

Sea URCHIN. See ECHINUS, HELMINTHOLOGY *Index*.

UREA. See CHEMISTRY.

URETERS. See ANATOMY, N° 101.

URETHRA. See ANATOMY, N° 107.

URIC Acid. See CHEMISTRY *Index*.

URIM *and* THUMMIM, among the ancient Hebrews, a certain oracular manner of conſulting God, which was done by the high-prieſt dreſſed in his robes, and having on his pectoral or breaſt-plate.

Various have been the ſentiments of commentators concerning the urim and thummim. Joſephus, and ſeveral others, maintain, that it meant the precious ſtones ſet in the high-prieſt's breaſt-plate, which by extraordinary luſtre made known the will of God to thoſe who conſulted him. Spencer believes that the urim and thummim were two little golden figures ſhut up in the pectoral as in a purſe, which gave reſponſes with an articulate voice. In ſhort, there are as many opinions concerning the urim and thummim as there are particular authors that wrote about them. The ſafeſt opinion, according to Broughton, ſeems to be, that the words *urim* and *thummim* ſignify ſome divine virtue and power annexed to the breaſt-plate of the high-prieſt, by which an oraculous anſwer was obtained from God when he was conſulted by the high-prieſt; and that this was called *urim* and *thummim*, to expreſs the clearneſs and perfection which theſe oracular anſwers always carried with them; for urim ſignifies "light," and thummim "perfection:" theſe anſwers not being imperfect and ambiguous, like the heathen oracles, but clear and evident. The uſe made of the urim and thummim was to conſult God in difficult caſes relating to the whole ſtate of Iſrael; and ſometimes in caſes relating to the king, the ſanhedrim, the general of the army, or ſome other great perſonage.

URINAL, in *Medicine*, a veſſel fit to receive and hold urine, and uſed accordingly for the convenience of ſick perſons. It is uſually of glaſs, but ſometimes of metal.

URINE, a fluid, ſeparated from the blood, and carried by the emulgent arteries to the kidneys, from whence it deſcends to the bladder by the uterus, and is from time to time emitted thence by the canal of the urethra. See ANATOMY, N° 107. Por the properties of urine, ſee CHEMISTRY *Index*.

URN, a kind of vaſe, of a roundiſh form, but biggeſt in the middle, like the common pitchers; now ſeldom uſed but in the way of ornament over chimney-pieces, in buffets, &c. The great uſe of urns among the ancients, was to preſerve the aſhes of the dead after they were burnt; for which reaſon they were called *cineraria*, and *urnæ cinerariæ*, and were placed ſometimes under the tombſtone whereon the epitaph was cut; and ſometimes in vaults in their own houſes. Urns were alſo uſed at their ſacrifices to put liquid things in.

UROGALLUS. See TETRAO, ORNITHOLOGY *Index*.

URSA, in *Aſtronomy*, the name of two conſtellations in the northern hemiſphere.

URSULINES, in church hiſtory, an order of nuns, founded originally by St Angela of Breſcia, in the year 1537; and ſo called from St Urſula, to whom they were dedicated.

URSUS, the BEAR, a genus of quadrupeds belonging to the order of *feræ*. See MAMMALIA *Index*.

URTICA, a genus of plants of the claſs of monœcia; and in the natural ſyſtem claſſed under the 53d order, *Scabridæ*. See BOTANY *Index*.

URTICA Marina. See *ANIMAL-Flower*.

USANCE, in *Commerce*, is a determined time fixed for the payment of bills of exchange, reckoned either from the day of the bills being accepted, or from the day of their date; and thus called becauſe regulated by the uſage and cuſtom of the places whereon they are drawn.

USE, in *Law*, the profit or benefit of lands and tenements; or a truſt and confidence repoſed in a perſon for the holding of lands, &c. that he to whoſe uſe the truſt is made ſhall receive the profits.

USHANT, an iſland of France, 15 miles weſt of the coaſt of Britanny, at the entrance of the Britiſh channel.

USHER, an officer or ſervant who has the care and direction of the door of a court, hall, chamber, or the like.

USHER of the Black Rod, the eldeſt of the gentlemen uſhers, daily waiters at court, whoſe duty is to bear the rod before the king at the feaſt of St George, and other ſolemnities.

USK, a river of Wales, which riſes on the weſt of Brecknockſhire, and runs ſouth-eaſt through that county and Monmouthſhire, falling into the mouth of the Severn.

USQUEBAUGH, a ſtrong compound liquor, chiefly taken by way of dram.

There are ſeveral different methods of making this liquor; but the following is eſteemed one of the beſt: To two gallons of brandy, or other ſpirits, put a pound of Spaniſh liquorice, half a pound of raiſins of the ſun, four ounces of currants, and three of ſliced dates; the tops of baum, mint, ſavory, thyme, and the tops of the flowers of roſemary, of each two ounces; cinnamon and mace, well bruiſed, nutmegs, aniſeeds, and coriander ſeeds, bruiſed likewiſe, of each four ounces; of citron or lemon, and orange-peel, ſcraped, of each an ounce: let all theſe infuſe 48 hours in a warm place, often ſhaking them together; then let them ſtand in a cool place for a week: after which the clear liquor is to be decanted off, and to it is to be put an equal quantity of neat white port, and a gallon of canary; after which it is to be ſweetened with a ſufficient quantity of double refined ſugar.

USTION, in *Pharmacy*, the preparing of certain ſubſtances by burning them.

USUFRUIT, in the *Civil Law*, the uſe or enjoyment of any lands or tenements; or the right of receiving the fruits and profits of an inheritance, or other thing, without a power of alienating or changing the property thereof.

USURER, a perſon charged with a habit or act of uſury.

USURIOUS CONTRACT, is any bargain or contract whereby a man is obliged to pay more intereſt for money than the ſtatute allows.

USURPATION, in *Law*, is an injurious uſing or enjoyment of a thing for continuance of time, that belongs of right to another.

USURY, an unlawful contract upon the loan of money, to receive the ſame again with exorbitant increaſe. Under the article INTEREST, it was obſerved, that by ſtatute 37 Hen. VIII. c. 9. the rate of intereſt was fixed at 10l. per cent. per annum: which the ſtatute 13 Eliz. c. 8. confirms, and ordains, that all brokers ſhall be guilty of a *præmunire* who tranſact any contracts for more, and the ſecurities themſelves ſhall be void. The ſtatute 21 Jac. I. c. 17. reduced intereſt to 8l. per cent.; and it having been lowered in 1650, during the uſurpation, to 6 per cent. the ſame reduction was re-enacted after the Reſtoration by ſtatute 12 Car. II. c. 13. and, laſtly, the ſtatute 12 Annæ, ſt. 2. c. 16. has reduced it to 5 per cent. Wherefore not only all contracts for taking more are in themſelves totally void, but alſo the lender ſhall forfeit treble the money borrowed. Alſo if any ſcrivener or broker take more than 5s. per cent. procuration-money, or more than 12d. for making a bond, he ſhall forfeit 20l. with coſts, and ſhall ſuffer impriſonment for half a-year.

UTERUS. See ANATOMY, N° 108.

UTICA, in *Ancient Geography*, a town of Africa Propria, on the Mediterranean: a Tyrian colony, and older than Carthage, (Sil. Italicus); its name, according to Bochart, denoting *old*: reckoned ſecond to it; but after the deſtruction of Carthage, became the capital and centre of all the Roman tranſactions in Africa, according to Strabo; who adds, that it ſtood on the ſame bay with Carthage, at one of the promontories called *Apollonium*, bounding the bay on the weſt ſide, the other to the eaſt called *Hermeia*, being at Carthage. It became famous by the death of Cato, who thence was called *Uticenſis*.

UTRECHT, one of the ſeven United Provinces or States of Holland, wholly ſurrounded by Holland and Guelderland, excepting a ſmall part of it that borders on the Zuyder Zee. Its greateſt length is about 32 miles, and breadth about 22. It enjoys a good air; and in moſt places the ſoil is fruitful, but in ſome ſandy, or what is called *turf-ground*, and in others overrun with wood. It is watered by the Leck, Rhine, Vecht, and other ſmaller rivers, beſides ſeveral canals; of which that extending from the village of Vreeſwyk to Utrecht is one of the chief.

UTRECHT, in Latin *Ultrajectum*, *Trajectum vetus* or *inferius*, or *Trajectum Rheni*, capital of a province of the ſame name, ſo called from its ancient ferry or paſſage here over the Rhine; the word being compounded of *trecht*, which in Dutch ſignifies "a ferry," and *oud* or *olt*, i. e. "old." It is a fair, large, and populous city, ſituated 19 miles from Amſterdam, 25 from Rotterdam, and 27 from Leyden. Here is a ſtately town-houſe, with a commandery of the Teutonic order, and a celebrated univerſity, which was founded in 1630, ſince which it hath flouriſhed greatly, though it has not all the privileges of moſt other univerſities; being wholly ſubject to the magiſtrates of the city. The mall without the town, having five rows of lofty limes on each ſide, is very pleaſant: and the phyſic-garden belonging to the univerſity is extremely curious. There are five churches here that have chapters; but the members of theſe purchaſe the places, of which ſome coſt 6000 or 7000 guilders. The ſtreams which run through ſeveral of the ſtreets, contribute much to the beauty and cleanlineſs of the town; and the canal that is cut from the Leck, and paſſes through it to Amſterdam, will carry ſhips of any burden. Pope Adrian VI. was a native of this city. Here, in 1579, the memorable union was formed between the ſeven provinces; and, in 1713, the celebrated peace concluded between France on the one part, and the allies on the other. The Papiſts have a nominal archbiſhop of this city; and there is a ſilk manufactory carried on in it, which employs a number of hands. The inhabitants are ſuppoſed to amount to 30,000. E. Long. 5. 8. N. Lat. 52. 7.

UTRICULARIA, a genus of plants of the claſs of diandria; and in the natural ſyſtem arranged under the 24th order, *Corydales*. See Botany *Index*.

UVA ursi. See Arbutus, Botany *Index*.

VULCAN, in Pagan worſhip, the god of ſubterraneous fire and metals, was the ſon of Jupiter and Juno; and was ſaid to be ſo remarkably deformed, that his father threw him down from heaven to the iſle of Lemnos, in which fall he broke his leg, and there he ſet up his forge, and taught men how to ſoften and poliſh braſs and iron. Thence he removed to the Liparian iſles, near Sicily, where, by the aſſiſtance of the Cyclops, he made Jupiter's thunderbolts, and armour for the other gods. Notwithſtanding the deformity of his perſon, he had a paſſion for Minerva, and by Jupiter's conſent made his addreſſes to her, but without ſucceſs. He was, however, more fortunate in his ſuit to Venus; who, after marriage, choſe Mars for her gallant; when Vulcan expoſed them to the ridicule of the other gods, by taking them in a net.

VULGATE, a very ancient Latin tranſlation of the Bible, and the only one acknowledged by the church of Rome to be authentic. See Bible.

VULNERARY, in *Medicine*, an epithet formerly given to remedies ſuppoſed to poſſeſs virtues for the cure of wounds and ulcers.

VULTUR, a genus of birds belonging to the order of *Accipitres*. See Ornithology *Index*.

VULVA. See Anatomy, N° 132.

UVULA. See Anatomy, N° 102.

UZ, or Utz, the country and place of reſidence of Job. In the genealogy of the patriarchs there are three perſons called *Uz*, either of which might give this diſtrict its name. The firſt was the grandſon of Sem, by his ſon Aram (Gen. xxii. 23.), who, according to Joſephus, occupied the Trachonitis, and Damaſcus, to the north of Paleſtine: but Job was among the ſons of the Eaſt. Another *Uz* was the ſon of Nahor, Abraham's brother (Gen. x. 21.), who appears to have removed, after paſſing the Euphrates, from Haran of Meſopotamia to Arabia Deſerta. The third *Uz* was a Horite, from Mount Seir (Gen. xxxvi. 28.), and thus not of Eber's poſterity. Now the queſtion is, from which of theſe Job's country, Uz, took its name: Not from the firſt, as is already ſhown; nor from the ſecond, becauſe his country is always called *Seir*, or *Edom*, never *Uz*; and then called a *ſouth*, not an *eaſt*, country, in Scripture. It therefore remains, that we look for the country and place of reſidence of Job in Arabia Deſerta; for which there was very probable reaſons. The plunderers of Job are called *Chaldeans* and *Sabeans*, next neighbours to him. Theſe Sabeans came not from Arabia Felix, but from a nearer Sabe in Arabia Deſerta (Ptolemy); and his friends, except Eliphaz the Themanite, were of Arabia Deſerta.

UZBECK Tartary. See Tartary.

W.

W, or w, is the 21ſt letter of our alphabet; and is compoſed, as its name implies, of two v's. It was not in uſe among the Hebrews, Greeks, or Romans; but chiefly peculiar to the northern nations, the Teutones, Saxons, Britons, &c. But ſtill it is not uſed by the French, Italians, Spaniards, or Portugueſe, except in proper names, and other terms borrowed from languages in which it is originally uſed, and even then it is ſounded like the ſingle v. This letter is of an ambiguous nature; being a conſonant at the beginning of words, and a vowel at the end. It may ſtand before all the vowels except *u*; as *water*, *wedge*, *winter*, *wonder*: it may alſo follow the vowels *a*, *e*, *o*, and unites with them into a kind of double vowel, or diphthong; as in *ſaw*, *few*, *cow*, &c. It alſo goes before *r*, and follows *ſ* and *th*; as in *wrath*, *ſwear*, *thwart*: it goes before *h* alſo, though in reality it is ſounded after it; as in *when*, *what*, &c. In ſome words it is obſcure, as in *ſhadow*, *widow*, &c.

WAAG, a river of Hungary, which riſes in the Carpathian mountains, and falls into the Danube oppoſite to the iſland of Schut.

WAAL, a river of the United Netherlands, being one of the branches of the Rhine, which runs from eaſt to weſt, through Guelderland; paſſing by Nimeguen, Tiel, Bommel, and Gorcum; and, uniting with the Maes, falls into the German ſea below the Briel.

WACHENDORFIA, a genus of plants of the claſs of triandria; and arranged in the natural method under the 6th order, *Enſatæ*. See BOTANY *Index*.

WADD, or WADDING, is a ſtopple of paper, hay, ſtraw, or the like, forced into a gun upon the powder, to keep it cloſe in the chamber; or to put up cloſe to the ſhot, to keep it from rolling out.

WADSET, in *Scots Law*. See LAW, N° clxix. 1.

WAFERS, or *Sealing WAFERS*, are made thus: Take very fine flour, mix it with glair of eggs, iſinglaſs, and a little yeaſt; mingle the materials; beat them well together; ſpread the batter, being made thin with gum-water, on even tin plates, and dry them in a ſtove; then cut them out for uſe.

You may make them of what colour you pleaſe, by tinging the paſte with braſil or vermilion for red; indigo or verditer, &c. for blue; ſaffron, tumeric, or gamboge, &c. for yellow.

WAGER *of LAW*. See *(Wager of)* LAW.

WAGER of Battel. See *(Wager of)* BATTEL.

WAGGON, a wheel-carriage, of which there are various forms, accommodated to the different uſes they are intended for. The common waggon conſiſts of the ſhafts or rods, being the two pieces which the hind horſe bears up; the welds; the ſlotes, or croſs pieces, which hold the ſhafts together; the bolſter, being that part on which the fore-wheels and the axle-tree turn in wheeling the waggon acroſs the road; the cheſt or body of the waggon, having the ſtaves or rails fixed thereon; the bales, or hoops which compoſe the top; the tilt, the place covered with cloth, at the end of the waggon. See MECHANICS, Sect. iv.

WAGTAIL. See MOTACILLA, ORNITHOLOGY *Index*.

WAIFS, BONA WAVIATA, are goods ſtolen, and waived or thrown away by the thief in his flight, for fear of being apprehended. Theſe are given to the king by the law, as a puniſhment upon the owner for not himſelf purſuing the felon, and taking away his goods from him. And therefore if the party robbed do his diligence immediately to follow and apprehend the thief (which is called *making freſh ſuit*), or do convict him afterwards, or procure evidence to convict him, he ſhall have his goods again. Waived goods do alſo not belong to the king till ſeized by ſomebody for his uſe; for if the party robbed can ſeize them firſt, though at the diſtance of 20 years, the king ſhall never have them. If the goods are hid by the thief, or left anywhere by him, ſo that he had them not about him when he fled, and therefore did not throw them away in his flight; theſe alſo are not *bona waviata*, but the owner may have them again when he pleaſes. The goods of a foreign merchant, though ſtolen and thrown away in flight, ſhall never be waifs: the reaſon whereof may be, not only for the encouragement of trade, but alſo becauſe there is no wilful default in the foreign merchant's not purſuing the thief, he being generally a ſtranger to our laws, our uſages, and our language.

WAIGATS STRAITS, ſituated between Nova Zembla and Ruſſia, through which the Dutch ſailed to the north, as high as 75°, in order to diſcover a north-eaſt paſſage to China and the Eaſt Indies.

WAINSCOT, in building, the timber-work that ſerves to line the walls of a room, being uſually made in pannels, and painted, to ſerve inſtead of hangings.

WAIVE, in *Law*, a woman that is put out of the protection of the law. She is called *waive*, as being forſaken of the law; and not *outlaw* as a man is; by reaſon women cannot be of the decenna, and are not ſworn in leets to the king, nor to the law, as men are; who are therefore within the law; whereas women are not, and ſo cannot be outlawed, ſince they never were within it.

WAKE, the print or track impreſſed by the courſe of a ſhip on the ſurface of the water. It is formed by the re-union of the body of water which was ſeparated by the ſhip's bottom whilſt moving through it; and may be ſeen to a conſiderable diſtance behind the ſtern, as ſmoother than the reſt of the ſea. Hence it is uſually obſerved by the compaſs, to diſcover the angle of lee-way.

A ſhip is ſaid to be in the wake of another when ſhe follows her on the ſame track, or a line ſuppoſed to be formed on the continuation of her keel.

Two diſtant objects obſerved at ſea are called in the wake of each other, when the view of the fartheſt is intercepted by the neareſt; ſo that the obſerver's eye and the two objects are all placed upon the ſame right line.

WAKE is the eve-feaſt of the dedication of churches, which is kept with feaſting and rural diverſions.

Mr Whitaker, in his Hiſtory of Mancheſter, has given a particular account of the origin of wakes and fairs. He obſerves, that every church at its conſecration received the name of ſome particular ſaint: this cuſtom was practiſed among the Roman Britons, and continued among the Saxons; and in the council of Cealchythe, in 816, the name of the denominating ſaint was expreſly required to be inſcribed on the altars, and alſo on the walls of the church, or a tablet within it. The feaſt of this ſaint became of courſe the feſtival of the church. Thus Chriſtian feſtivals were ſubſtituted in the room of the idolatrous anniverſaries of heatheniſm: accordingly, at the firſt introduction of Chriſtianity among the Jutes of Kent, Pope Gregory the Great adviſed, what had been previouſly done among the Britons, viz. Chriſtian feſtivals to be inſtituted in the room of the idolatrous, and the ſuffering day of the martyr whoſe relics were repoſited in the church, or the day on which the building was actually dedicated, to be the eſtabliſhed feaſt of the pariſh. Both were appointed and obſerved; and they were clearly diſtinguiſhed at firſt among the Saxons, as appears from the laws of the Confeſſor, where the *dies dedicationis*, or *dedicatio*, is repeatedly diſcriminated from the *propria feſtivitas ſancti*, or *celebratio ſancti*. They remained equally diſtinct to the Reformation; the dedication-day in 1536 being ordered for the future to be kept on the firſt Sunday in October, and the feſtival of the patron ſaint to be celebrated no longer. The latter was, by way of pre-eminence, denominated the *church's holiday*, or its peculiar feſtival; and while this remains in many pariſhes at preſent, the other is ſo utterly annihilated in all, that Biſhop Kennet (ſays Mr Whitaker) knew nothing of its diſtinct exiſtence, and has attributed to the day of dedication what is true only concerning the ſaint's day. Thus inſtituted at firſt, the day of the tutelar ſaint was obſerved, moſt probably by the Britons, and certainly by the Saxons, with great devotion. And the evening before every ſaint's day, in the Saxon Jewiſh method of reckoning the hours, being an actual hour of the day, and

and therefore like that appropriated to the duties of public religion, as they reckoned Sunday from the firſt to commence at the ſunſet of Saturday; the evening preceding the church's holyday would be obſerved with all the devotion of the feſtival. The people actually repaired to the church, and joined in the ſervices of it; and they thus ſpent the evening of their greater feſtivities in the monaſteries of the North, as early as the concluſion of the ſeventh century.

Theſe ſervices were naturally denominated from their late hours *wæcan* or *wakes*, and *vigils* or *eves*. That of the anniverſary at Rippon, as early as the commencement of the eighth century, is expreſsly denominated the *vigil*. But that of the church's holiday was named *cyric wæcan*, or church-wake, the church-vigil, or church eve. And it was this commencement of both with a wake, which has now cauſed the days to be generally preceded with vigils, and the church-holiday particularly to be denominated the *church-wake*. So religiouſly was the eve and feſtival of the patron ſaint obſerved for many ages by the Saxons, even as late as the reign of Edgar, the former being ſpent in the church, and employed in prayer. And the wakes, and all the other holidays in the year, were put upon the ſame footing with the Octaves of Chriſtmas, Eaſter, and of Pentecoſt. When Gregory recommended the feſtival of the patron ſaint, he adviſed the people to erect booths of branches about the church on the day of the feſtival, and to feaſt and be merry in them with innocence. Accordingly, in every pariſh, on the returning anniverſary of the ſaint, little pavilions were conſtructed of boughs, and the people indulged in them to hoſpitality and mirth. The feaſting of the ſaint's day, however, was ſoon abuſed; and even in the body of the church, when the people were aſſembled for devotion, they began to mind diverſions, and to introduce drinking. The growing intemperance gradually ſtained the ſervice of the vigil, till the feſtivity of it was converted, as it now is, into the rigour of a faſt. At length they too juſtly ſcandalized the Puritans of the laſt century, and numbers of the wakes were diſuſed entirely, eſpecially in the eaſt and ſome weſtern parts of England; but they are commonly obſerved in the north, and in the midland counties.

This cuſtom of celebrity in the neighbourhood of the church, on the days of particular ſaints, was introduced into England from the continent, and muſt have been familiar equally to the Britons and Saxons; being obſerved among the churches of Aſia in the ſixth century, and by thoſe of the weſt of Europe in the ſeventh. And equally in Aſia and Europe, on the continent and in the iſlands, theſe celebrities were the cauſes of thoſe commercial marts which we denominate *fairs*. The people reſorted in crowds to the feſtival, and a conſiderable proviſion would be wanted for their entertainment. The proſpect of intereſt invited the little traders of the country to come and offer their wares; and thus, among the many pavilions for hoſpitality in the neighbourhood of the church, various booths were erected for the ſale of different commodities. In larger towns, ſurrounded with populous diſtricts, the reſort of the people to the wakes would be great, and the attendance of traders numerous; and this reſort and attendance conſtitute a fair.—Baſil expreſsly mentions the numerous appearance of traders at theſe feſtivals in Aſia, and Gregory notes the ſame cuſtom to be common in Europe. And as the feſtival was obſerved on a feria or holiday, it naturally aſſumed to itſelf, and as naturally communicated to the mart, the appellation of *feria* or fair. Indeed ſeveral of our moſt ancient fairs appear to have been uſually held, and have been continued to our time, on the original church-holidays of the places: beſides, it is obſervable, that fairs were generally kept in church-yards, and even in the churches, and alſo on Sundays, till the indecency and ſcandal were ſo great as to need reformation.

Wake-ROBIN. See ARUM, BOTANY *Index*.

WALACHIA, a province of Turkey in Europe, bounded on the north by Moldavia and Tranſylvania, on the eaſt and ſouth by the river Danube, and on the weſt by Tranſylvania. It is 225 miles in length, and 125 in breadth; and was ceded to the Turks by the treaty of Belgrade, in 1739. It abounds in good horſes and cattle; and there are mines of ſeveral kinds. The ſoil is ſo fertile, that it is capable of producing any thing; and there are good paſtures, with wine, oil, and all manner of European fruits. The inhabitants are chiefly of the Greek church.

WALCHEREN, an iſland of the Low Countries, and one of the principal of thoſe of Zealand; ſeparated from Dutch Flanders by the mouth of the Scheldt. It is about nine miles in length, and eight in breadth; and though it lies low, has good arable and paſture land. The chief town of this iſland and the whole province is Middleburgh. But the principal ſea port is Fluſhing, which is ſtrongly fortified. Walcheren was taken by the Britiſh forces in Auguſt 1809; but it ſoon after was abandoned, the troops having ſuffered ſeverely by ſickneſs.

WALDEN, a town of Eſſex, commonly called *Saffron Walden*, with a market on Saturdays, and two fairs on Midlent Saturday for horſes, and November 1ſt for cows. It is remarkable for the plenty of ſaffron that grows about it. This town was incorporated by Edward VI. and is governed by a mayor and 24 aldermen. It is 27 miles north-weſt-by-north of Chelmsford, and 43 north-eaſt of London. E. Long. 0. 20. N. Lat. 52. 4.

WALDENSES. See WALDO.

WALDO, a merchant of Lyons in the latter part of the 12th century, who applying himſelf to the ſtudy of the Scriptures, and finding no warrant there for ſeveral of the Romiſh doctrines, particularly that of tranſubſtantiation, publicly oppoſed them. His followers, who from him were called *Waldenſes*, being chaſed from Lyons, ſpread over Dauphiné and Provence; upon which Philip II. is ſaid to have razed 300 gentlemen's ſeats, and deſtroyed ſeveral walled towns to ſtop their growth: but this, inſtead of ſuppreſſing, ſpread them over a great part of Europe. The articles of their faith, which they drew up and dedicated to the king of France, agreed in moſt points with thoſe of the preſent Proteſtants. In the year 1200, thoſe of them who dwelt in the province of Albigeois in Languedoc, from whence they were called *Albigenſes*, ſtood upon their defence; upon which Philip drove them into Bohemia, Savoy, and England. The cruſade againſt them is ſaid to have conſiſted of 500,000 men, who wore their croſſes on their breaſts, to diſtinguiſh themſelves from thoſe who went to the Holy Land, and wore them on their ſhoulders.

WALES, a country ſituated in the ſouth-weſt part of Britain, into which the ancient Britons retired from the perſecution of the Saxons. Anciently it was of greater extent than it is at preſent, and comprehended all the country beyond the Severn, that is, beſides the 12 counties included in it at preſent, thoſe of Herefordſhire and Monmouthſhire, which now are reckoned a part of England, were then inhabited by three different tribes of the Britons, namely, the Silures, the Dimetæ, and the Ordovices. The Romans were never able to ſubdue them, till the reign of Veſpaſian, when they were reduced by Julius Frontinus, who placed garriſons in their country to keep them in awe. Though the Saxons made themſelves maſters of all England, they never could get poſſeſſion of Wales, except the counties of Monmouthſhire and Herefordſhire, formerly a part of Wales. About the year 870, Roderic king of Wales divided it among his three ſons; and the names of theſe diviſions were, *Demetia*, or *South-Wales; Poveſia*, or *Powis-Land*; and *Venedotia*, or *North Wales*. Another diviſion is mentioned afterwards in the records, viz. North Wales, South Wales, and Weſt Wales; the laſt comprehending the counties of Monmouth and Hereford. The country derived the name of *Wales*, and the inhabitants that of *Welſh*, from the Saxons, who by thoſe terms denote a country and people to which they are ſtrangers; for the Welſh, in their own language, call their country *Cymry*, and their language *Cymraeg*. They continued under their own princes and laws from the above-mentioned period, and were never entirely ſubjected to the crown of England till the reign of Edward I. when Llewellin ap Gryffith, prince of Wales, loſt both his life and dominions. Edward, the better to ſecure his conqueſt, and to reconcile the Welſh to a foreign yoke, ſent his queen to lie in at Caernarvon, where ſhe was delivered of a prince; to whom the Welſh, on that account, the more readily ſubmitted. Ever ſince that time, the eldeſt ſons of the kings of England have commonly been created princes of Wales, and as ſuch enjoy certain revenues from that country.

As to the character of the Welſh, they are ſaid to be a brave, hoſpitable people; and though very jealous of affronts, paſſionate, and haſty, yet are eaſily reconciled. The common people look with a ſuſpicious eye on ſtrangers, and bear a hereditary grudge to the Engliſh nation, by whom their anceſtors were expelled from the fineſt parts of the iſland. The gentlemen are apt to value themſelves upon the antiquity of their families; and with ſome reaſon, as they can generally trace them much higher than the inhabitants of moſt other countries.

All the better ſort, both in town and country, can ſpeak Engliſh, eſpecially in the counties bordering upon England. The common people, in general, only ſpeak their own language, which is the ancient Britiſh; and not only differs entirely from the Engliſh, but has very little affinity with any of the weſtern tongues, unleſs we ſhould except the Gaelic, Erſe, or Iriſh. It is ſaid to be a dialect of the ancient Celtic, and in many reſpects to reſemble the Hebrew. Moſt of the clergy are natives of the country, and underſtand Engliſh ſo well, that they could exerciſe their functions in any part of Britain. The public worſhip, however, is as often performed in Welſh as in Engliſh, excepting in the towns, where the latter is the prevailing language. The inhabitants are computed at about 300,000.

The country, though mountainous, eſpecially in North Wales, is far from being barren or unfruitful; the hills, beſides the metals and minerals they contain, feeding vaſt herds of ſmall black cattle, deer, ſheep, and goats, and their valleys abounding in corn, as their ſeas and rivers do in fiſh. Here are alſo wood, coal, and turf for fuel, in abundance.

Wales is bounded on all ſides by the ſea and the Severn; except on the eaſt, where it joins to the counties of Cheſter, Salop, Hereford, and Monmouth. Its length, from the ſouthernmoſt part of Glamorganſhire to the extremity of Flintſhire north, is computed at about 113 miles; and its greateſt breadth, from the river Wye eaſt to St David's in Pembrokeſhire weſt, is nearly of the ſame dimenſions, being about 90 miles.

After the conqueſt of Wales by Edward I. very material alterations were made in their laws, ſo as to reduce them nearer to the Engliſh ſtandard, eſpecially in the forms of their judicial proceedings: but they ſtill retained very much of their original polity, particularly their rule of inheritance, viz. that their lands were divided equally among all the iſſue male, and did not deſcend to the eldeſt ſon alone. By other ſubſequent ſtatutes their provincial immunities were ſtill farther abridged: but the finiſhing ſtroke to their dependency was given by the ſtatute 27 Hen. VIII. c. 26. which at the ſame time gave the utmoſt advancement to their civil proſperity, by admitting them to a thorough communication of laws with the ſubjects of England.—Thus were this brave people gradually conquered into the enjoyment of true liberty; being inſenſibly put upon the ſame footing, and made fellow-citizens, with their conquerors.

It is enacted by the 27 Hen. VIII. 1. That the dominion of Wales ſhall be for ever united to the kingdom of England. 2. That all Welſhmen born ſhall have the ſame liberties as other king's ſubjects. 3. That lands in Wales ſhall be inheritable according to the Engliſh tenures and rules of deſcent. 4. That the laws of England, and no other, ſhall be uſed in Wales: beſides many other regulations of the police of this principality. And the 34 and 35 Hen. VIII. c. 26. confirms the ſame, adds farther regulations, divides it into 12 ſhires, and, in ſhort, reduces it into the ſame order in which it ſtands at this day; differing from the kingdom of England in only a few particulars, and thoſe too of the nature of privileges (ſuch as having courts within itſelf, independent of the proceſs of Weſtminſter-hall), and ſome other immaterial peculiarities, hardly more than are to be found in many counties of England itſelf.

New W*ALES*. See *New* B*RITAIN*.

*New South-*W*ALES*. See *New* H*OLLAND*.

Prince of W*ALES*. See R*OYAL Family*.

W*ALKING Leaf*, an inſect. See M*ANTIS Sycifolia*, E*NTOMOLOGY Index*.

WALL, in *Architecture*, the principal part of a building, as ſerving both to incloſe it, and to ſupport the roof, floors, &c.—Walls are diſtinguiſhed into various kinds, from the matter whereof they conſiſt; as plaſter or mud walls, brick walls, ſtone walls, flint or boulder walls, and boarded walls. See A*RCHITECTURE*.

Cob or *Mud* W*ALL*. In thoſe parts of England where ſtone is ſcarce, it is uſual to make walls and houſes of mud,

mud, or, as it is called in Devonſhire, *cob;* which is a compoſition of earth and ſtraw, wet up ſomewhat like mortar, but well beat and trod together. When a wall is making, after being raiſed to a certain height, it is allowed time to pitch or ſettle before the work is reſumed. Some value themſelves on their ſkill in building with this compoſition; the price, when materials are found, is generally in Devonſhire 3s. per perch of 16½ feet; but a ſtone foundation coſts more. Houſes built with this, being covered with thatch, are very dry and warm; a cob wall, if in a good ſituation, will laſt 50 or 60 years or more. When pulled down, they are uſed as manure, and new earth employed to rebuild with.

WALLACE, Sir William, a gallant general of the Scots, who endeavoured to reſcue his country from the Engliſh yoke; but being taken priſoner, he was unjuſtly tried by the Engliſh laws, condemned, and executed as a traitor to Edward I. in 1304. See Scotland, n° 103, *et ſeq.*

WALLACHIA. See Walachia.

WALLER, Edmund, a celebrated Engliſh poet, was the ſon of Robert Waller, Eſq. of Agmondeſham in Buckinghamſhire, by Anne, the ſiſter of the great Hamden who diſtinguiſhed himſelf ſo much in the beginning of the civil wars. He was born in 1605; and his father dying when he was very young, the care of his education fell to his mother, who ſent him to Eton ſchool. He was afterwards ſent to King's college in Cambridge, where he muſt have been very aſſiduous in his ſtudies, ſince, at ſixteen or ſeventeen years of age, he was choſen into the laſt parliament of King James I. and ſerved as burgeſs for Agmondeſham. He began to exerciſe his poetical talent ſo early as the year 1623; as appears from his verſes "upon the danger his majeſty (being prince) eſcaped in the road of St Andero;" for there Prince Charles, returning from Spain that year, had like to have been caſt away. It was not, however, Mr Waller's wit, his fine parts, or his poetry, that ſo much occaſioned him to be firſt publicly known, as his carrying off the daughter and ſole heireſs of a rich citizen, againſt a rival whoſe intereſt was eſpouſed by the court. It is not known at what time he married his firſt lady; but he was a widower before he was 25, when he began to have a paſſion for Sachariſſa, which was a fictitious name for the lady Dorothy Sidney, daughter to the earl of Leiceſter, and afterwards wife to the earl of Sunderland. He was now known at court, careſſed by all who had any reliſh for wit and polite literature; and was one of the famous club of which Lord Falkand, Mr Chillingworth, and other eminent men, were members. He was returned burgeſs for Agmondeſham in the parliament which met in April 1640. An intermiſſion of parliaments having diſguſted the nation, and raiſed jealouſies againſt the deſigns of the court, which would be ſure to diſcover themſelves whenever the king came to aſk for a ſupply, Mr Waller was one of the firſt who condemned the preceding meaſures. He ſhowed himſelf in oppoſition to the court, and made a ſpeech in the houſe on this occaſion; from which we may gather ſome notion of his general principles in government; wherein, however, he afterwards proved very variable and inconſtant. He oppoſed the court alſo in the long parliament which met in November following, and was choſen to impeach Judge Crawley, which he did in a warm and eloquent ſpeech, July 16th 1641. This ſpeech was ſo highly applauded, that 20,000 copies of it were ſold in one day. In 1642, he was one of the commiſſioners appointed by the parliament to preſent their propoſitions of peace to the king at Oxford. In 1643, he was deeply engaged in a deſign to reduce the city of London and the tower to the ſervice of the king; for which he was tried and condemned, together with Mr Tomkins his brother-in-law, and Mr Challoner. The two latter ſuffered death; but Mr Waller obtained a reprieve: he was, however, ſentenced to ſuffer a year's impriſonment, and to pay a fine of 10,000l. After this, he became particularly attached to Oliver Cromwell, upon whom he wrote a very handſome panegyric. He alſo wrote a noble poem on the death of that great man.

At the Reſtoration, he was treated with great civility by Charles II. who always made him one of the party in his diverſions at the duke of Buckingham's and other places. He wrote a panegyric upon his majeſty's return; which being thought to fall much ſhort of that he had before written on Oliver Cromwell, the king one day aſked him in raillery, "How is it, Waller, that you wrote a better encomium on Cromwell than on me?" "May it pleaſe your majeſty," anſwered he, we poets generally ſucceed beſt in fiction." He ſat in ſeveral parliaments after the Reſtoration, and continued in the full vigour of his genius to the end of his life, his natural vivacity bearing him up, and making his company agreeable to the laſt. He died of a dropſy in 1687, and was interred in the churchyard of Beaconsfield, where a monument is erected to his memory. Mr Waller has been honoured as the moſt elegant and harmonious verſifier of his time, and a great refiner of the Engliſh language. The beſt edition of his works, containing poems, ſpeeches, letters, &c. is that publiſhed in quarto by Mr Fenton, to 1730.

WALLIS, Dr John, a celebrated mathematician, was educated at Cambridge; where he became fellow of Queen's college, and continued ſo till, by his marriage, he vacated his fellowſhip. In 1640, he received holy orders, and became chaplain to the lady Vere. While he lived in this family, he cultivated the art of deciphering; and it is ſaid, that the elector of Brandenburg, for whom he explained ſeveral letters written in ciphers, ſent him a gold chain and medal. In 1643 he publiſhed, "Truth tried; or Animadverſions on the Lord Brooke's treatiſe, called *The Nature of Truth*, &c." The next year he was choſen one of the ſcribes or ſecretaries to the aſſembly of divines at Weſtminſter. Dr Peter Turner, Savilian profeſſor of geometry in Oxford, being ejected by the parliament-viſitors in 1649, Mr Wallis was appointed to ſucceed him in that place. In 1653 he publiſhed at Oxford a Grammar of the Engliſh Tongue in Latin. In 1655 he entered the liſts with Mr Hobbes; and their controverſy laſted a conſiderable time. In 1657 the Doctor publiſhed his Mathematical Works. Upon the death of Dr Langbaine, he was choſen cuſtos archivorum of the univerſity. After the Reſtoration he met with great reſpect, the king himſelf entertaining a favourable opinion of him on account of ſome ſervices he had done both to his royal father and himſelf. He was therefore confirmed in his places, admitted one of the king's chaplains in ordinary, and appointed one of the divines empowered to review the book of common prayer. He complied with the terms of the act of uniformity, and continued a ſteady conformiſt till his death. He was one of the firſt members of the Royal Society, and correſponded with many learned men. In 1697, the curators of the univerſity preſs at Oxford thought it for the honour of the univerſity to collect the mathematical works of the Doctor, which had been printed ſeparately, ſome in Latin, ſome in Engliſh, and publiſhed them all together in the Latin tongue, in three vols, folio. He died in 1703. He ſpeaks of himſelf thus: “It hath been my endeavour all along to act by moderate principles, being willing whatever ſide was uppermoſt, to promote any good deſign for the true intereſt of religion, of learning, and of the public good.” Beſides the works above-mentioned, he publiſhed many others.

WALLOONS, a name for the inhabitants of a conſiderable part of the Netherlands, viz. Artois, Hainault, Naum, Luxemburgh, and part of Flanders and Brabant.

WALNUT-TREE. See JUGLANS, BOTANY *Index*.

WALPOLE, SIR ROBERT, earl of Orford, was born at Houghton in Norfolk, September 6th, 1674, and educated on the foundation at Eton ſchool. Thence he was elected to King's College in Cambridge; but, ſucceeding to the family eſtate by the death of his elder brother, he reſigned his fellowſhip. In 1700 he was choſen member of parliament for King's Lynn, and repreſented that borough in ſeveral ſucceeding parliaments. In 1705, he was nominated one of the council to Prince George of Denmark, lord high admiral of England; in 1707, appointed ſecretary at war; and, in 1709, treaſurer of the navy. In 1710, upon the change of the miniſtry, he was removed from all his poſts, and held no place afterwards during the queen's reign. In 1711 he was expelled from the houſe of commons for what they called notorious corruption in his office as ſecretary at war. The borough of Lynn, however, re-elected him; and, though the houſe declared the election void, yet they perſiſted in the choice. In the well-known debate relating to Steele for publiſhing the Criſis, he greatly diſtinguiſhed himſelf in behalf of liberty, and added to the popularity he had before acquired.

On the death of the queen, a revolution of politics took place, and the Whig party prevailed both at court and in the ſenate. Walpole had before recommended himſelf to the houſe of Hanover by his zeal for its cauſe, when the commons conſidered the ſtate of the nation with regard to the Proteſtant ſucceſſion: and he had now the honour to procure the aſſurance of the houſe to the new king (which attended the addreſs of condolence and congratulation), “That the commons would make good all parliamentary funds.” It is therefore not to be wondered at, that his promotion ſoon took place after the king's arrival; and that in a few days he was appointed receiver and pay-maſter general of all the guards and garriſons, and of all other the land forces in Great Britain, paymaſter of the royal hoſpital at Chelſea, and likewiſe a privy counſellor. On the opening of a new parliament, a committee of ſecrecy was choſen to inquire into the conduct of the late miniſtry, of which Walpole was appointed chairman; and, by his management, articles of impeachment were read againſt the earl of Oxford, Lord Bolingbroke, the duke of Ormond, and the earl of Strafford. The eminent ſervice he was thought to have done the crown, by the vigorous proſecution of thoſe miniſters who were deemed the chief inſtruments of the peace, was ſoon rewarded by the extraordinary promotions to the offices of firſt commiſſioner of the treaſury, and chancellor and under treaſurer of the exchequer.

In two years time he reſigned all his offices, on account of a miſunderſtanding which took place between him and the reſt of the miniſtry about certain ſupplies demanded for the ſupport of his majeſty's German dominions. On the day of his reſignation he brought in the famous ſinking-fund bill, which he preſented as a country gentleman, ſaying, that he hoped it would not fare the worſe for having two fathers; and that his ſucceſſor Mr Stanhope would bring it to perfection. His calling himſelf the father of a project, which hath ſince been ſo often employed to other purpoſes than were at firſt declared, gave his enemies frequent opportunity for ſatire and ridicule; and it hath been ſarcaſtically obſerved, that the father of this fund appeared in a very bad light when viewed in the capacity of a nurſe. In the next ſeſſion of parliament, Walpole oppoſed the miniſtry in every thing; and even Wyndham or Shippen did not exceed him in patriotiſm. Upon a motion in the houſe for continuing the army, he made a ſpeech of above an hour long, and diſplayed the danger of a ſtanding army in a free country, with all the powers of eloquence. Early in 1720 the rigour of the patriot began to ſoften, and the complaiſance of the courtier to appear; and he was again appointed paymaſter of the forces, and ſeveral of his friends were found ſoon after in the liſt of promotions. No doubt now remained of his entire converſion to court meaſures; for, before the end of the year, we find him pleading as ſtrongly for the forces required by the war-office as he had before declaimed againſt them, even though at this time the ſame pretences for keeping them on foot did not exiſt.

It was not long before he acquired full miniſterial power, being appointed firſt lord commiſſioner of the treaſury, and chancellor of the exchequer; and, when the king went abroad in 1723, he was nominated one of the lords juſtices for the adminiſtration of government, and was ſworn ſole ſecretary of ſtate. About this time he received another diſtinguiſhed mark of the royal favour; his eldeſt ſon then on his travels being created a peer, by the title of Baron Walpole of Walpole. In 1725 he was made knight of the Bath, and the year after knight of the Garter. The meaſures of his adminiſtration, during the long time he remained prime or rather ſole miniſter, have been often canvaſſed with all the ſeverity of critical inquiry. It is difficult to diſcern the truth through the exaggerations and miſrepreſentations of party. He has indeed been accuſed of employing the ſinking fund for the purpoſes of corruption, of which it was long the faſhion to call him the father; but the man who reflects on the tranſactions of Charles II. and his infamous cabal, will acquit him of the latter part of this charge. He was an enemy to war, and the friend of commerce; and becauſe he did not reſent ſome petty inſults of the court of Spain ſo ſuddenly as the fiery part of the nation thought he ſhould have done, a formidable oppoſition was formed againſt him in the houſe, which had influence enough to employ in its cauſe almoſt all the wit of the nation. Pulteney and Pitt were the great leaders of the party in the houſe of commons; while Bolingbroke and Pope and Johnſon, and almoſt every man of genius, exerted themſelves without doors to enlighten, by pamphlets in proſe and verſe, the minds of the people, and ſhow the neceſſity of a Spaniſh war. This he ſtrenuouſly oppoſed, becauſe he knew that the foreign ſettlements of that power are very remote, and in a climate deſtructive to Engliſhmen; and that ſuch of them as we might be able to take, we could not poſſibly retain. The oppoſition however prevailed. The nation was indulged in a war, of which it ſurely had no cauſe to boaſt of the ſucceſs; and it is now univerſally known, that the greater part of thoſe who with honeſt intentions had, either in parliament or out of it, been engaged to run down the miniſter, lived to repent of their conduct, and do juſtice to the man whom they had ſo pertinaciouſly vilified.

In order to encourage commerce and improve the revenue, Sir Robert projected a ſcheme for an extenſion of the exciſe, as the only means of putting a ſtop to the frauds of merchants and illicit traders. This was another ground of clamour to the orators within, and the wits without, doors; and while the oppoſition repreſented it as a meaſure big with public miſchief, Swift and Pope occaſionally alluded to it as an oppreſſion calculated to deprive private life of all its comforts. The miniſter was therefore obliged to abandon the ſcheme; but in a ſucceeding adminiſtration it was partly carried into execution, at the expreſs ſolicitation of the principal perſons concerned in that article of trade which it was ſuggeſted would be moſt affected by it; and afterwards the moſt popular miniſter that ever directed the councils of this country declared in full ſenate, that if a time ſhould ever arrive which was likely to render the project feaſible, he would himſelf recommend an extenſion of the exciſe laws as a meaſure of the greateſt advantage to commerce, to the revenue, and to the general intereſts of the kingdom.

In 1742 the oppoſition prevailed; and Sir Robert being no longer able to carry a majority in the houſe of commons, reſigned all his places, and fled for ſhelter behind the throne. He was ſoon afterwards created earl of Orford; and the king, in conſideration of his long and faithful ſervices, granted him a penſion of 4000l. per annum. The remainder of his life he ſpent in tranquillity and retirement, and died, in 1745, in the 71ſt year of his age.

He has been ſeverely, and not unjuſtly, cenſured for that ſyſtem of corruption by which he almoſt avowed that he governed the nation; but the objects which he had in view are now acknowledged to have been in a high degree praiſe-worthy. Johnſon, who in the earlier part of his life had joined the other wits in writing againſt his meaſures, afterwards honoured his memory for the placability of his temper, and for keeping this country in peace for ſo many years; and Mr Burke has * declared, that his only defect as a miniſter was the want of ſufficient firmneſs to treat with contempt that popular clamour, which, by his yielding to it, hurried the nation into an expenſive and unjuſt war. But his rancorous proſecution of Atterbury biſhop of Rocheſter (ſee ATTERBURY), by a bill of pains and penalties, may be conſidered as ſomething worſe than a defect: it was a fault for which no apology can be made; becauſe, whether that prelate was innocent or guilty, of his guilt no legal proof ever appeared. In that inſtance the conduct of the miniſter was the more extraordinary, that on other occaſions he choſe to gain over the diſaffected by mildneſs and beneficence, even when he had ſufficient proofs of their guilt. Of this the following anecdote, communicated by Lord North to Dr Johnſon, is a ſufficient proof. Sir Robert having got into his hands ſome treaſonable papers of his inveterate enemy Shippen, ſent for him, and burnt them before his eyes. Some time afterwards, while Shippen was taking the oaths to the government in the houſe of commons, Sir Robert, who ſtood next to him, and knew his principles to be the ſame as ever, ſmiled; upon which Shippen, who had obſerved him, ſaid "Egad, Robin, that's hardly fair."

To whatever objections his miniſterial conduct may be liable, in his private character he is univerſally allowed to have had amiable and benevolent qualities. That he was a tender parent, a kind maſter, a beneficent patron, a firm friend, an agreeable companion, are points that have been ſeldom diſputed; and ſo calm and equal was his temper, that Pulteney, his great rival and opponent, ſaid, he was ſure that Sir Robert Walpole never felt the bittereſt invectives againſt him for half an hour.

About the end of Queen Anne's reign, and the beginning of George I.'s, he wrote the following pamphlets. 1. The Sovereign's Anſwer to the Glouceſterſhire Addreſs. The Sovereign meant Charles duke of Somerſet, ſo nicknamed by the Whigs. 2. Anſwer to the Repreſentation of the Houſe of Lords on the State of the Navy, 1709. 3. The Debts of the Nation ſtated and conſidered, in four Papers, 1710. 4. The Thirty-five Millions accounted for, 1710. 5. A Letter from a foreign Miniſter in England to Monſieur Pettecum, 1710. 6. Four Letters to a Friend in Scotland upon Sacheverell's Trial; falſely attributed in the General Dictionary to Mr Maynwaring. 7. A Short Hiſtory of the Parliament. It is an account of the laſt ſeſſion of the queen. 8. The South-Sea Scheme conſidered. 9. A Pamphlet againſt the Peerage Bill, 1719. 10. The Report of the Secret Committee, June 9th, 1715.

WALRUS. See TRICHECUS, MAMMALIA *Index*.

WALSH, WILLIAM, an Engliſh critic and poet, the ſon of Joſeph Walſh, Eſq. of Abberley in Worceſterſhire, was born about the year 1660. He became a gentleman commoner of Wadham college, Oxford, but left the univerſity without taking a degree. His writings are printed among the works of the Minor Poets, printed in 1749. He was made gentleman of the horſe in Queen Anne's reign; and died in 1708. He was the friend of Mr Dryden and of Mr Pope; the former of whom eſteemed him the beſt critic then living; and Mr Pope has celebrated his character in the Eſſay on Criticiſm.

WALSINGHAM, a town of Norfolk, with a market on Fridays, and a fair on Whit-Monday, for horſes and pedlars ware; it is ſeated not far from the ſea; and in former times was famous for its college of canons, and was greatly frequented by pilgrims who went to pay their devotions to the image of the Virgin Mary at the chapel, where there are two fine ſprings, called the

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* *Letters on a Regicide Peace.*

the *Virgin Mary's wells.* Not many years ago there were found here by a huſbandman, 100 urns full of aſhes, which were ſuppoſed to be thoſe which the Romans filled with the aſhes of the dead. It is 22 miles north-weſt of Norwich, and 117 north-north-eaſt of London. E. Long. 0. 53. N. Lat. 52. 56.

WALSINGHAM, Thomas, an Engliſh Benedictine monk of the monaſtery of St Alban's, who lived about the year 1440. He applied himſelf to the hiſtory and antiquity of his country, in quality of hiſtoriographer to the king; and compoſed the Hiſtory of King Henry VI. with other works.

Walsingham, *Sir Francis*, miniſter and ſecretary of ſtate during the reign of Queen Elizabeth, and one of the greateſt politicians of his time, was deſcended from a noble and ancient family at Chiſlehurſt. After having made great progreſs in his ſtudies at Cambridge, he was twice ſent ambaſſador to France, and at his return to England was employed in the moſt important affairs, became ſecretary of ſtate, and was one of the commiſſioners for the trial of Mary queen of Scotland. Sir Francis was undoubtedly one of the moſt refined politicians and moſt penetrating ſtateſman that any age ever produced. He had an admirable talent, both in diſcovering and managing the ſecret receſſes of the heart. He had his ſpies in moſt courts in Chriſtendom, and allowed them a liberal maintenance; for it was his maxim, That knowledge cannot be bought too dear. In 1587 the king of Spain having made vaſt preparations, which ſurpriſed, and kept all Europe in ſuſpenſe, Walſingham employed his utmoſt endeavours for the diſcovery of that important ſecret; and accordingly procured intelligence from Madrid, that the king had informed his council of his having diſpatched an expreſs to Rome, with a letter written with his own hand to the pope, acquainting him with the true deſign of his preparations. and begging his bleſſings upon him; which for ſome reaſons he could not diſcloſe till the return of the courier. The ſecret being thus lodged with the pope, Walſingham, by means of a Venetian prieſt, whom he retained at Rome as a ſpy, got a copy of the original letter, which was ſtolen out of the pope's cabinet by a gentleman of the bed-chamber, who took the key out of the pope's pocket while he ſlept. After this, by his dexterous management, he cauſed the Spaniards bills to be proteſted at Genoa, which ſhould have ſupplied them with money for their extraordinary preparations and by this means he happily retarded this formidable invaſion for a whole year. In ſhort, he ſpent his whole time and faculties in the ſervice of Queen Elizabeth; on which account her majeſty was heard to ſay, "That in diligence and ſagacity he exceeded her expectations." However, after all his eminent ſervices to his country, this man gave a remarkable proof at his death, which happened on the 6th of April 1590, how far he preferred the public intereſt to his own; he being ſo poor, that excepting his library, which was a very fine one, he had ſcarcely effects enough to defray the expence of his funeral. His principal works are, 1. Memoirs and Inſtructions for the uſe of Ambaſſadors, with his Letters and Negociations. 2. Political Memoirs.

WALTHERIA, a genus of plants in the claſs monadelphia, and in the natural ſyſtem arranged under the 37th order, *Columniferæ*. See Botany *Index*.

WALTON, Bryan, Biſhop of Cheſter, a learned Engliſh divine, who gained great reputation by his edition of the Polyglot bible, with his Prolegomena in the beginning; which is more exact, ſays Father Simon, than any other which had been publiſhed on that ſubject. He died in 1661.

WAMPUM, the money uſed by the North American Indians. It is much uſed in all their treaties as a ſymbol of friendſhip. It is made of a ſhell of a particular ſpecies of Venus.

WAPENTAKE, is the ſame with what is called a *hundred*; eſpecially uſed in the north counties beyond the river Trent. The word ſeems to be of Daniſh original, and to be ſo called for this reaſon: When firſt this kingdom, or part thereof, was divided into wapentakes, he who was the chief of the wapentake or hundred, and who is now called a *high conſtable*, as ſoon as he entered upon his office, appeared in a field on a certain day on horſeback with a pike in his hand, and all the chief men of the hundred met him there with their lances, and touched his pike; which was a ſign that they were firmly united to each other by the touching their weapons. But Sir Thomas Smith ſays, that anciently muſters were made of the armour and weapons of the ſeveral inhabitants of every wapentake; and from thoſe that could not find ſufficient pledges for their good abearing, their weapons were taken away and given to others; from whence he derives the word.

WAR.

INTRODUCTION.

1 Diviſion of the ſubject.

IN treating the ſubject of war, we may conſider it firſt in a *political* and *moral* point of view, as one of thoſe powerful engines employed by civil governments, to bring about ſome ends which they deem beneficial to the community over which they preſide; and ſecondly, in a *theoretical* and *practical* point of view, as a *ſcience* or an *art*, which the neceſſities or the follies of mankind have rendered an important object of conſideration, not only to certain individuals, but in ſome meaſure to ſociety at large.

2 Political objects and cauſes of war.

From the numerous calamities incident to war, it ſhould be preſumed that no wiſe or good government would have recourſe to means ſo dangerous and expenſive, till after all other means of producing the ends they have in view had failed of ſucceſs. The oſtenſible objects for which a nation or community engages in a war, are uſually to prevent or repel the aſſaults, encroachments, or invaſions of its neighbours; to revenge ſome inſult or injury which the community, its allies, or dependents, may have ſuſtained; to compel ſome other nation or community to reſpect what are called the *law of nations*, and the *rights of civil ſociety*; or to preſerve that due and equable *balance of power* among neighbouring ſtates, which has of late been conſidered as an eſſential point in the political economy of civilized nations. We ſay that theſe are uſually the *oſtenſible* objects of war; for though it will ſcarcely be denied that ambition, avarice, religious bigotry, a deſire of dominion, and a thirſt of military fame, have been the real cauſes of many of thoſe long and bloody wars which have deſolated the face of nature, and heaped miſery and wretchedneſs on millions of human beings, we believe few heroes and conquerors, either of ancient or modern times, have had the honeſty or effrontery to avow theſe as the real motives of their military expeditions. Yet, if we examine the pages of hiſtory, we ſhall ſcarcely find a war, from the Battle of the Kings recorded by the ſacred hiſtorian, to the preſent conteſt which has for 17 years involved all Europe in confuſion and bloodſhed, and reduced many of its faireſt ſtates and provinces under the ſubjection of a ſingle monarch, in which *one* or other of theſe latter motives has not, at leaſt to one party, been a principal inducement.

Among the political objects of war, we muſt not omit to mention one which, though perhaps leſs openly avowed than any other, has, in monarchical and ariſtocratical governments, always formed a material part of the ſtate policy;—we mean the object of preventing tumults and commotions among the people, by engaging them in a foreign war. It was long ago obſerved by a good judge of human nature [*], "that no body can be healthful without exerciſe, neither natural body nor politic;" and that "to a kingdom or a ſtate, a juſt and honourable war is the true exerciſe." That politicians have often acted on theſe principles, is certain. On the juſtice of the principles themſelves, we preſume not to decide, though we may ſafely expreſs a doubt whether the remedy be not worſe than the diſeaſe, and whether theſe popular commotions might not be prevented with equal eaſe, and with more advantage to the nation, by employing the populace in ſuch works of improvement as may advance the manufactures, commerce, or internal comforts of the ſtate.

3
Exuberant population regarded as a primary cauſe of war.

An able and ingenious writer conſiders a redundance of population as one of the chief primary cauſes of war. "One of its firſt cauſes and moſt powerful impulſes, was undoubtedly an inſufficiency of room and food; and, greatly as the circumſtances of mankind have changed ſince it firſt began, the ſame cauſe ſtill continues to operate, and to produce, though in a ſmaller degree, the ſame effects. The ambition of princes would want inſtruments of deſtruction, if the diſtreſſes of the lower claſſes did not drive them under their ſtandards. A recruiting ſerjeant always prays for a bad harveſt, and a want of employment, or, in other words, a redundant population [†]." This redundance he propoſes to obviate, and thus to counteract one of the principal cauſes of war, by throwing obſtacles in the way of marriage. Without calling in queſtion the juſtneſs of his poſition, we do not ſee the neceſſity of the remedy which he propoſes. We muſt acknowledge ourſelves ſuch friends to the increaſe of population as to think that every encouragement ought to be given to it, inſtead of throwing obſtacles in its way. There are few countries ſo populous, or ſo completely cultivated, as to render it neceſſary to plunge them into wars, in order to diminiſh the number of inhabitants, which might be abundantly ſupported, were agriculture encouraged, and gluttony repreſſed.

4
Impolicy of war.

Whatever may be the objects for which a nation goes to war; whatever the cauſes which have induced her to have recourſe to ſuch an expedient, we may venture, from hiſtory and experience, to affirm that ſhe will gain little ſolid advantage by the conteſt. She may drive an invading enemy from her dominions, and purſue him to his own; ſhe may acquire plunder and territory, and may raiſe her name among the neighbouring ſtates by her victories and proweſs; but all theſe, except the *firſt*, will ſcarcely compenſate for the blood and treaſure which ſhe has expended, and for the check given to her agriculture, manufactures and commerce, by drawing off many of the labouring part of the community to ſupply the fleets and armies of the ſtate. Theſe are the inevitable conſequences even of a ſucceſsful war; and ſhould it prove otherwiſe, the calamities and diſtreſſes of the vanquiſhed may readily be conceived. Even to the eſtabliſhed government of a ſtate, war, while it appears to ſtrengthen their hands and increaſe their influence, is fraught with difficulty and danger. No ſituation of affairs is ſo well calculated to ſhow the abilities or inſufficiency of a cabinet as this, and melancholy is the fate of that nation whoſe adminiſtration is then conducted by a weak, inexperienced, or profligate miniſtry; but be they ever ſo able or ſo upright, ſtill the want of ſucceſs, or a reverſe of fortune, will lower them in the opinion of the people, and will compel them at laſt to conclude a diſadvantageous, perhaps a diſhonourable peace, or quit their poſts and leave the taſk to a more popular or ſucceſsful adminiſtration.

The evils of war do not terminate on the return of peace. Many of the burdens which it had impoſed on the people muſt ſtill continue, to diſcharge the debt contracted by the ſtate; while the ſudden diſbanding of the fleets and armies pours into the community numbers of idle and diſſipated men, averſe to labour, and accuſtomed to ſcenes of confuſion, ſlaughter and rapine. At no time are robberies, murders, or ſeditions ſo frequent as on the termination of a long protracted war; at none are the internal peace and quiet of a nation in ſo much danger.

5
Moral evils of war.

On the *moral* evils of war we ſurely need not enlarge. In itſelf, when undertaken without neceſſity, it is an act of the moſt criminal and atrocious nature; and the aggreſſors are accountable for all the horrid conſequences which may attend it. "The pomp and circumſtance of glorious war" may form a deſirable ſubject for the poet and the hiſtorian; but the Chriſtian and the philoſopher muſt regard it with horror and deteſtation, as the greateſt evil with which providence has been pleaſed to arm the hands of its miniſters to puniſh and afflict mankind. A late amiable and learned prelate has laboured to prove that "the frequency, duration, and cruelty of wars (in Chriſtendom) are leſs now than in ancient times;" [*] but we think that neither his reaſoning nor his examples are capable of eſtabliſhing the firſt part of this poſition. If we take the laſt 700 years, and compare it with an equal period of ancient hiſtory; if we recollect the *cruſades*, the almoſt continual ſtruggles between France and Britain, the civil diſſenſions in both theſe mighty empires, the wars between the Ruſſians and their neighbours, the Turks, the Poles, and the Swedes; if we advert to the reigns of Edward

6
War ſcarcely leſs frequent now than formerly.

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[*] *Bacon.*

[†] *Malthus on Population*, Edit. 1803. p. 500.

[*] *Porteus's Sermons*, Serm. xii.

Edward III. of England, Charles V. and Philip II. of Spain, Louis XIV. of France, Guſtavus Adolphus and Charles XII. of Sweden, Frederick II. of Pruſſia, and Catherine II. of Ruſſia; and laſtly, if we turn our attention to the long and ruinous conteſts which diſtinguiſh our own times, we ſhall find little cauſe to boaſt of having profited by the pacific leſſons of our Saviour, whoſe great object was to promote "*peace on earth*," *and good will and brotherly love among the children of men.*

7 Modern wars leſs ſanguinary than thoſe of ancient times.

There is indeed one conſolatory circumſtance with reſpect to the modern ſyſtem of warfare, that our wars are now leſs ſanguinary than thoſe of ancient times. The immenſe ſlaughter which attended ſome of the battles in the Greek and Roman wars, where the greater part of the vanquiſhed army was frequently put to the ſword, is familiar to our claſſical readers; but in modern warfare, even of the large armies that have appeared in the field on the continent of Europe, we ſeldom find ſo many as 30,000 killed and wounded on both ſides, a number vaſtly inferior to what fell of the Romans at Cannæ, and by no means equal to the loſs of the Carthaginians at the battle of Zama. This diminiſhed ſlaughter is attributed, and we believe with juſtice, to the uſe of fire-arms; and it is computed that in this mode of fighting not more than one muſket ball in 40 takes effect, and not more that one in 400 proves fatal. The introduction of theſe weapons, therefore, however it may be declaimed againſt by theoriſts, muſt be conſidered as a real improvement in the art of war; and it is ſincerely to be regretted that the uſe of them ſhould be laid aſide. If, however, the preſent practice of deciding battles by the bayonet and the ſabre be continued, it is to be feared that we ſhall ſoon rival the ancients as much in the ſanguinary nature of our wars as in their frequency.

8 What war is juſtifiable.

After what we have ſaid on the impolicy of war, and the moral evils which attend it, it will ſcarcely be expected that we ſhould allow it to be juſtifiable, except in caſes of neceſſity. Indeed we think that war can be juſtified only on the principles of ſelf-defence. When a nation is invaded, or attacked in relation to her undoubted rights and principles, it is then, and then only, that ſhe has a pretence for war. We will not, indeed, go ſo far as to aſſert, that ſhe ought to await the attack. While ſhe takes the beſt methods for defending her territories at home, it is doubtleſs proper, eſpecially for a maritime ſtate, to meet the enemy half-way, and by a timely and ſpirited reſiſtance, endeavour to avert thoſe greater evils which would attend a ſyſtem of puſillanimity and neglect.

In the preſent ſtate of human nature, war muſt be regarded as a neceſſary evil, and as it is ſometimes unavoidable, the principles and practice of it muſt be ſtudied by thoſe who are to ſuperintend or to conduct its operations. It is this neceſſity that has given occaſion to the art of war, the practice of which is to form the ſubject of the preſent article.

9 War conſidered theoretically.

Before we enter on the immediate object of this eſſay, however, it may not be improper to enumerate thoſe branches of knowledge which conſtitute the *principles* of the military art, and of which no officer who expects to have a principal command in military operations ſhould be ignorant. We ſhall firſt mention thoſe ſciences which ſhould form a part of the education of every commanding officer, whether military or naval; and we ſhall then diſtinguiſh between thoſe which are moſt applicable to the land and the ſea ſervice.

Among the firſt branches of a military education muſt be enumerated the modern languages of French and German; GEOGRAPHY, by which we would underſtand, not merely the deſcription of countries, ſtates, and kingdoms, but a knowledge of their political conſtitution, reſources, and productions, and of the manners, cuſtoms, and character of their inhabitants; HISTORY, eſpecially that of modern Europe, and of the Greeks and Romans. Among particular hiſtories we would recommend thoſe of Polybius, Xenophon, Tacitus, with the Commentaries of Cæſar, in ancient hiſtory; and Davila's account of the civil wars of France, Guicciardini's hiſtory of the Italian wars, the hiſtory of the ſeven years war by Frederick the Great, with a particular attention to the beſt hiſtories of his own country, and of the wars in which ſhe has been engaged. After theſe preliminary branches follow the rudiments of mathematics, including common and logarithmic ARITHMETIC, the elements of theoretical and practical GEOMETRY, plane and ſpherical TRIGONOMETRY, the principles of SURVEYING, CONIC SECTIONS, and their application to PROJECTILES; certain parts of natural philoſophy, eſpecially MECHANICS; and the principles of DRAWING plans, maps, and charts.

Beſides theſe, a military officer ſhould be inſtructed in FORTIFICATION and GUNNERY, the nature of military exerciſes, and the duties of the various officers attached to an army; while the naval officer ſhould particularly attend to ASTRONOMY, HYDRODYNAMICS, NAVIGATION, the principles of SEAMANSHIP, and of SHIP-BUILDING.

10 Practice of war.

There is perhaps no art or profeſſion, in the practice of which the ſuperiority of *example* over *precept* is more apparent than in war, inſomuch that we may lay it down as an axiom, that no man can be a ſoldier or a ſailor from theory alone. It is not from books that we are to learn the art of war, though there is no doubt that they may greatly aſſiſt and improve the ſkill and experience acquired in the field or on the ocean. In theſe active ſcenes have been formed the great commanders, whoſe lives and actions are peruſed with ſo much avidity; and the only method of ſucceſsfully imitating their exploits, and emulating their fame, is to encounter the dangers and the hardſhips to which they were expoſed, and to learn how to command, by firſt learning to obey. A conſiderable ſhare of the mechanical part of war may be acquired in a well-regulated military or naval ſchool; but the experience neceſſary for a commander is to be gained only in actual ſervice.

The practical part of war is uſually divided into *military tactics*, and *naval tactics*; a diviſion which we ſhall here adopt, though we have thought proper to bring the whole under one article. As the ſpace, which we had originally allotted to theſe ſubjects, has unavoidably been reduced one half, we ſhall be able to give little more than a general outline, eſpecially of *military tactics*, reſerving the fuller diſcuſſion for *naval tactics*, which, to a nation whoſe chief dependence is on her fleets, muſt be the moſt uſeful and the moſt intereſting part of the ſubject.

It would be vain for us to attempt any hiſtorical account of the progreſſive improvements that have been made in the art of war. Indeed this would be to repeat much of what has already been detailed under the principal hiſtorical articles of this work; for the hiſtory of nations, as it is commonly treated, is little more than a hiſtory of their wars. We might, no doubt, bring forward much curious information reſpecting the offenſive and defenſive weapons of different ages and countries, and the character and organization of their armies; but for thoſe and other matters of a ſimilar nature, we may refer our readers to the following reſpectable authorities: Vegetius *De re militari;* Polybius's *Hiſtory, with the Commentaries of* Folard; Salmaſius *De re militari Romanorum;* Tacitus's *Vita Agricolæ;* Rollin's *Ancient Hiſtory;* Potter's *Grecian Antiquities;* Kennet's and Adam's *Roman Antiquities;* Goguet's *Origin of Laws, Arts, &c.;* Daniel *Hiſtoire de la Milice Françoiſe;* Gough's *Sepulchral Monuments;* Aſcham's *Toxophilus*, and Groſe's *Hiſtory of the Engliſh Army, and Eſſay on Ancient Armour*.

At a period like the preſent, when the two greateſt powers of Europe are ſtruggling for glory and dominion, it will not be thought unintereſting, or irrelevant to the ſubject of the preſent article, if we offer a comparative ſtatement of the preſent military and naval eſtabliſhments of theſe two mighty empires, with a ſketch of the military character of their armies; and with theſe we ſhall conclude our preliminary obſervations.

11
Preſent military eſtabliſhment of the French.

According to a ſtatement made to the French government at the commencement of 1805, the grand total of the French armies conſiſted of 570,964 men; viz. infantry of the line, 341,412; light infantry, 100,130; cavalry, 77,488; artillery, 46,489; engineers, 5445. Since that time, more than 100,000 have been added, and, according to the beſt authority, the preſent total does not fall ſhort of 700,000 men *. This vaſt body is divided into companies for both cavalry and infantry; a certain number of companies forming a battalion of infantry, or a ſquadron of cavalry. The denomination of regiment is appropriated to the cavalry and artillery, while a ſimilar body of infantry is called a half brigade. The commanding officer of a regiment is called colonel; but the commander of a large body of infantry is called chief of brigade. The names of lieutenant-colonel and major are changed for thoſe of chief of a battalion and chief of a ſquadron. Thoſe general officers which in other armies are called major-generals, are, in the French ſervice, denominated generals of brigade, and lieutenant-generals are there generals of diviſion.

The corps of engineers has for its officers 8 inſpectors general, 34 directors, 124 captains of the firſt claſs, 117 captains of the ſecond claſs, 33 lieutenants of the firſt claſs, 21 of the ſecond claſs, and 20 pupils under the lieutenants. Attached to this corps are 6 companies of miners, commanded by a chief of battalion. Each company is officered by a captain-commandant, a ſecond captain, firſt and ſecond lieutenant. Twelve battalions of miners; each battalion, containing 8 companies, forming in all 1606 men, including officers. The battalion ſtaff is compoſed of a chief of battalion, an adjutant major, and an adjutant. Each company is officered by a captain, a lieutenant, and ſublieutenant.

To raiſe and recruit this great military force, the French government has, ſince the year 1798, had recourſe to one of the moſt tyrannical meaſures which was ever adopted by a deſpotic monarchy, we mean that of *conſcription*, by which every man within a certain age, is made liable, under circumſtances of the greateſt rigour, to ſerve in the armies of the ſtate. This ſyſtem of conſcription is exceedingly complex; but we are enabled, from a reſpectable periodical publication, to preſent ſuch a ſummary of it as will be readily underſtood. France is divided into about 30 military governments, ſubject to a general of diviſion and his ſtaff, to which commiſſaries are attached as executive officers. The civil diviſion conſiſts of 122 departments; 24 of which have been acquired ſince the overthrow of the monarchy, excluſive of Tuſcany, not included in any part of this ſtatement. The departments are divided into diſtricts or *arrondiſſements*, from three to five in number; the *arrondiſſements* into cantons, and the cantons into municipalities, amounting to about 55,000. Each department is governed by a prefect and his council, compoſed of a commiſſary of police, a mayor, and certain inſpectors, denominated *counſellors of prefecture;* the diſtrict or *arrondiſſement*, by a ſubprefect and his council, of a ſimilar formation. The cantons and municipalities are under the ſuperviſion of an adminiſtration, compoſed of the civil authorities, with a preſident at their head. A mayor, a commiſſary of police, and two officers of the government, ſtyled *adjuncts*, are allotted to each diviſion having a population above 5000 ſouls. Theſe ſeveral authorities are in ſtrict ſubordination to each other, and at the controul of the prefects and ſubprefects, who, themſelves, are charged with a weighty and inflexible reſponſibility as to the military levies.

By the code *de la conſcription*, all Frenchmen, between the ages of 20 and 25, are liable to ſerve. They are divided into five claſſes, from which the municipal adminiſtration draws up the liſts for the ballot. Theſe are tranſmitted to the prefects, by whom they are ſent to the war miniſter, and when properly adjuſted, the ſubprefect proceeds to the drawing of the quota impoſed on each diſtrict. The conſcripts drawn are formed into three diviſions, the firſt called *conſcripts for actual ſervice*, the ſecond the *reſerve*, and the third *ſupplementary conſcripts*. They are marched in companies of 100 men, to the places which are eſtabliſhed as depots, where they are furniſhed with their arms and clothes. After this they are trained and exerciſed, ſo as to be inured to unremitting labour and fatigue.

What gives peculiar energy to the French military ſyſtem, is the circumſtance that their officers riſe by merit and experience, and not by intereſt. By a law of the directory, no perſon (with the exception of engineers) could become officers, who had not ſerved three years in a ſubordinate capacity. The revolution naturally opened the way to merit; and, ſeconded by this admirable policy, has filled all the poſts of their army with men, who unite in themſelves the qualities of the ſoldier, with the excellencies that qualify for command. It is not hazarding too much to aſſert, that nine-tenths of the preſent French officers have ſprung from the ranks. Educated in diſtant camps, they know no other country, and, habituated by long devotion to the trade of war, it has become their element and their paſſion. Their whole fortune is ſtaked on the ſword; and their attachment is therefore neceſſarily ſecured, under the

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* *Edin. Review*, vol. xiii. p. 455.

Introduction.

auſpicious influence of a leader, whoſe indefatigable ambition occupies them in their favourite purſuits, and whoſe *liberal impartiality* feeds the hope of preferment, and divides the fruits of conqueſt. To their credit and example is due much of that ſpirit, which, notwithſtanding the cauſes of alienation hitherto obſerved, ſeems to animate the whole frame of the army; and no ſmall ſhare of that portentous ſucceſs which has attended the courſe of the French arms. Of the eighteen *marechaux d'empire*, fourteen have either emerged from the ranks, or aſcended from the loweſt employments. Moſt of the generals of diviſion, and others who hold the principal commands, have the ſame origin, and ſufficiently prove, that war is an experimental ſcience, and that military renown is not the prerogative of birth, but the harveſt of toil, or the bounty of fortune *.

12
Late naval eſtabliſhment.

We have no certain means of aſcertaining the preſent naval eſtabliſhment of the French empire, though, as it may be ſaid to have the command of the navies of Holland, Ruſſia, and the remains of that of Denmark, it muſt ſtill be regarded as of no trifling ſtrength. The principal fleets are indeed kept blocked up by thoſe of Britain, in the harbours of Breſt, Rochefort, Toulon, the Scheldt, and the Texel; but the eſcape of any of theſe might be the means of conveying a conſiderable military force to the remaining colonies, or to the leſs powerful allies of France. In 1791, the French fleet conſiſted of 73 ſhips of the line, 67 frigates, 19 corvettes, and 67 ſmall craft, making a total of 226. Since that time, however, have taken place the great naval victories of Howe, St Vincent, Duncan, and Nelſon, by which the greater part of *that* navy has been carried into Britiſh ports.

13
Preſent military eſtabliſhment of Britain.

In eſtimating the military eſtabliſhment of Britain, we ſhall, for the ſake of more accurate compariſon, firſt take the ſame period of 1805. The Britiſh land forces then conſiſted of 21,223 cavalry, 124,878 infantry (including 20,747 men for limited ſervice, and 21,208 belonging to foreign and provincial corps in Britiſh pay), 89,809 militia, 8559 artillery, beſides about 430,000 volunteers, making a total of 674,469. To theſe muſt be added the royal artillery, the horſe brigade, the brigade of gunners and drivers, and companies of foreign artillery, amounting to 16,670, and the corps of artificers and labourers, including 704 men. Thus the whole military force of Britain, in 1805, amounted to 691,843 †.

Since the paſſing of Mr Windham's act, this number is ſomewhat diminiſhed, though our military force is now probably more effective. At the end of 1808 it ſtood as follows. Two regiments of life-guards, one regiment of royal horſe-guards, 7 of dragoon guards, 25 of dragoons, 3 battalions of riflemen, 7 battalions of foot-guards, 5 of light infantry, 176 battalions of infantry, a corps of royal horſe artillery, a regiment of royal foot artillery, a corps of royal engineers, a brigade of artillery drivers, and a waggon train. The dragoons, independent of the royal life and horſe guards, amounted to 19,200; the battalions of riflemen and light infantry to 8000; the infantry of the line to 149,600; the king's German legion to about 20,000; excluſive of about 96,000 regular militia, 250,000 local militia, and about 50,000 volunteers; making an effective force of about 580,000 men.

Each regiment of not more than 500 men is officered by a colonel, a lieutenant-colonel, a major, 10 captains, 10 lieutenants, 8 enſigns, an adjutant, quartermaſter, paymaſter, a ſurgeon and aſſiſtant ſurgeon; a ſergeant major, a quartermaſter-ſergeant, with 30 ordinary ſergeants, 30 corporals, a drum-major and 20 drummers. If the regiment amount to 750 men, it has uſually an addition of ſecond lieutenant-colonel, a ſecond major, 10 ſergeants, and 10 corporals.

The gradation of rank among the officers of the Britiſh army is as follows. Under the king, who commands the whole as *captain-general*, is the *commander in chief*, then follow the *field-marſhals*, *generals*, *lieutenant-generals*, *major-generals*, *brigadier-generals*, *colonels*, *lieutenant-colonels*, *majors*, *captains*, and *ſubalterns*. The different departments of the army are under the ſuperintendence of an *adjutant-general*, a *quartermaſter-general*, a *barrack-maſter general*, a *commiſſary-general*, a *paymaſter-general*, a *board of ordnance*, and a *medical board*. See ADJUTANT, QUARTERMASTER, &c.

The army of the line is recruited by enliſtment; the recruits receive a bounty, and are engaged to ſerve for a limited period, or for life. The militia is filled up by ballot, in the ſeveral counties to which it belongs, and alſo receives recruits by enliſtment or by proxy. Hence the Britiſh ſoldier, while he conſiders himſelf as the ſervant of the king and the ſtate, juſtly boaſts of partaking in the general liberty of the ſubject. He is protected by fixed and definite laws, againſt the diſcretionary power of his commanding officer, and is encouraged to perform his duty by the liberality of his country; and not, as in France, compelled to it by the fear of puniſhment. His diſcipline indeed is ſtrict; but he feels none of that ſevere and tyrannical coercion which ſeems to be the firſt principle of motion in the armies of Napoleon.

14
Naval eſtabliſhment.

In its naval eſtabliſhment, Britain juſtly boaſts of being ſuperior to every nation in the world. The number of her fleets, and the courage and diſcipline of her ſeamen, have given her the unrivalled dominion of the ſeas, of which it would be difficult for the whole combined navy of Europe to deprive her. In 1809, the naval force of Britain conſiſted of 157 ſhips of the line, 19 from 50 to 44, 184 frigates, 181 ſloops, 308 brigs, making a *total* of 849 in commiſſion; beſides 56 of the line, 12 50's, 56 frigates, 44 ſloops, 24 brigs, *total* 192 in ordinary and refitting; and 50 ſhips of the line, 20 frigates, 20 ſloops, 10 brigs, *total* 100, building: making a grand *total* of 1141.

The progreſſive advance of our navy will appear by attending to the following recital of its tonnage at different periods, from the reign of Henry VIII. to the preſent time.

	Year.	Tons about
At the death of Henry VIII.	1547	12,400
Edward VI.	1553	11,000
Mary,	1558	7000
Elizabeth,	1603	17,000
James I.	1625	19,000
Rebellion,	1641	22,400
At the death of Charles I.	1649	uncertain.
At the Reſtoration,	1660	57,460
At the death of Charles II.	1685	103,558
Abdication of James II.	1688	101,900

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* Ibid, p. 431—451.

† Playfair's Geography, vol. ii.

	Year.	Tons about
At the death of William III.	1702	159,000
Anne,	1714	167,170
George I.	1727	170,860
George II.	1760	321,200
31ſt December,	1788	413,660
	1806	776,000
	1809	800,000

It appears, however, that notwithſtanding the vaſt increaſe of our navy, not a ſingle dockyard has been added to it ſince the reign of William III. about 109 years ago, at which time the tonnage of the naval force of this kingdom amounted to nearly 160,000 tons; it is now nearly 800,900 tons, or about five times as large *.

In ſketching the military character of the French and Britiſh armies at the commencement of the 19th century, we ſhall avail ourſelves of the obſervations of an anonymous, but able and apparently impartial publication, which appeared ſoon after the peace of Amiens, entitled *The Military Character of the European Armies at the Peace of Amiens.*

15 Military character of the French army.

The aſtoniſhing ſucceſs which has attended the French arms on the continent of Europe, is to be attributed partly to the regular organization and ſevere diſcipline eſtabliſhed by the *Code de la Conſcription*, but it is ſtill more to be aſcribed to the ſkill, experience, and activity of their officers. The French generals early diſcovered the advantages reſulting from diſpatch. The alertneſs of the ſoldiers, the lightneſs of their baggage, and their inattention to regularity in time of action, enabled them to execute their movements with a celerity which has frequently enſured ſucceſs. In an open country, lines could not be preſerved without difficulty. The French armies were therefore formed in columns. Brigade ſucceeded brigade, and when one diviſion was repulſed, and fell back on the columns in the rear, thoſe in their turn attacked the enemy, or ſuſtained his ſhock, and freſh troops perpetually came forward, to ſupply the place of thoſe which had been defeated.

The French battalions have no field-pieces attached to them; but this want is amply compenſated by their flying artillery, which is compoſed of the flower of the French ſoldiers, and by its boldneſs and rapidity of movement, ſupplies the place of that large train of artillery with which the other European armies are uſually burdened. It is a conſtant maxim in the French armies to have a body of reſerve, compoſed of their beſt troops, and under the command of an able general. If the main body ſhould be beaten, the reſerve covers their retreat, and on more than one occaſion it has ſnatched the victory from the hands of the enemy.

The French generals, like rich and bold gamſters, are inceſſantly tempting fortune. They look upon their loſſes as nothing, provided they ſucceed in the end. The little value at which they eſtimate their men, the certainty of being able to replace them, the perſonal ambition of their chief, and the cuſtomary ſuperiority of their numbers, afford them an advantage which cannot be counteracted but by great ſkill, conduct and activity.

16 Military character of the Britiſh army.

The ſoldiers of Britain are as intrepid by land as her ſailors by ſea. Their want of ſucceſs on the continent cannot be aſcribed to their want of bravery, but rather to the organization of the Britiſh armies, their inferiority of numbers, or the inexperience of the officers by whom they are commanded. Moſt of their commanding officers, inſtead of conforming to general regulations, follow their own particular plans and ideas, according to their ſeveral geniuſes, acquirements, and prejudices. In a nation, which from the ſpirit of its conſtitution and the habits of its people, is formed rather for naval than military operations, a miniſtry, however enlightened, ſcarcely poſſeſſes that authority which is neceſſary to give uniformity to the different departments of the army, to conſtitute a regular and correſponding whole, and to ſurmount thoſe obſtacles which are thrown in the way of all uniformity of military ſyſtem, by the diſtance and diſtribution of the troops. The ſmall numbers in which Britiſh troops are generally compelled to act on the continent, and their mixture with thoſe of other nations, to which they are ſometimes even ſubſervient, are circumſtances extremely diſadvantageous.

In a military life, good faith, honour, and courage, are the principal qualifications, and theſe are eminently conſpicuous in the Britiſh army. Their military ardour is greater than what is ſeen in any other ſervice, but this is in a great meaſure damped among the officers by the difficulty of promotion. Intereſt with miniſters, and the neceſſity of raiſing money to defray the expences of the different departments of the ſtate, though far from being the moſt equitable, are here unhappily among the firſt means of military promotion.

The ſoldiers of the Britiſh army are poſſeſſed of elements to enable them, under a commander of abilities and officers of experience, to be the beſt troops in the world. They require neither brandy nor ſelf-conceit to make them brave; their courage is innate; it is a national inſtinct. Their officers too uſually poſſeſs much greater information on general topics than thoſe of all other European nations, as education is more cultivated in Britain than elſewhere. They are attached to their profeſſion, and follow it rather from generous motives and military ſpirit, than like mercenaries from a view of intereſt and profit.

On the political and moral principles of war, ſee Cicero *De Officiis*, Grotius *De Jure Belli et Pacis*, Puffendorff's *Law of Nature and Nations*, and Machiavel's *Diſcorſi*; and on the principles of war conſidered as a *ſcience*, ſee a *memoir* by Maizeroy, in the 40th volume of *Hiſtoire de l'Academie des Inſcriptions et Belles Lettres*, and Folard's *Commentaries on Polybius*.

PART I. MILITARY TACTICS.

17 Nature and object of military tactics.

SOME writers on the military art diſtinguiſh *tactics* from what they call *ſtrategy*; underſtanding by the latter the ſcience of military movements when not in ſight of the enemy, or at leaſt out of the range of their ſhot; while they deſcribe the former to be the ſcience of military movements in ſight of an enemy, or within the range

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* Statement by Lord Melville.

range of cannon ſhot. We do not ſee the neceſſity of this diſtinction; and under the head of military tactics we ſhall conſider whatever relates to military operations on land.

It is not poſſible for us, within the very ſcanty limits to which we are now reduced, to give any thing like a regular treatiſe on the military art. We ſhall therefore endeavour to ſelect the moſt uſeful and intereſting topics, and ſupply the place of diſquiſition by numerous plates with appropriate explanations.

The ſcience of military tactics comprehends the diſpoſition and arrangement of troops, whether on marches, in camps, or in line of battle; the attack and defence of poſts; the conſtruction and ſuperintendence of the works by which they are to be defended; the conducting of ſieges; and the defence of beſieged places. Theſe are the principal operations of a ſoldier, and theſe we ſhall briefly conſider nearly in the order in which we have enumerated them.

18
Of directing the march of an army

To direct the march of an army is not one of the leaſt difficult parts of a general's duty. To do this with ability, he muſt be well acquainted with the nature of the country through which his troops are to paſs, with the obſtacles which are likely to oppoſe them in their progreſs, and with the diſpoſition of the inhabitants. Our buſineſs here is only with the firſt of theſe conſiderations. There are three deſcriptions of countries which may become the theatre of war; an open country interſected by rivers, a mountainous, and a woody country. The march of an army through the firſt, as far as reſpects the face of the country alone, is ſeldom difficult, except in the paſſage of rivers, which we ſhall conſider by and bye; and the laſt deſcription of country is now ſo uncommon in Europe, that we need not dwell on it. A mountainous country, however, preſents numerous difficulties to call forth the abilities and experience of a commander, as in ſuch a country, not only are the roads winding and difficult of acceſs, but the unevenneſs of the ground, and the intervals between the hills render it very eaſy for an enemy with a ſmall force, to oppoſe and diſtreſs a numerous army.

19
through a mountainous country.
Plate DXLIV.

The plan in Plate DXLIV. is intended to illuſtrate the march of an army through a mountainous country. At A is ſhown the poſition of the army previous to its march, with the artillery and baggage P, drawn up under their proper eſcorts, in front of the camp. At B are parties of huſſars conſtituting the advanced guard of the army on its march; and at C are parties of infantry forming the advanced guard of the columns in which the army is diſpoſed. D repreſents the infantry forming the head of the columns; E the park of artillery and waggons attached to it; F, battalions of artillery, G the cavalry, H the baggage of the army, and I their eſcort. At K are parties of huſſars, and at L, parties of dragoons. M repreſents the infantry of the reſerve forming the rear guard, and N plattoons of infantry ſent forward upon the heights, to cover the flanks of the principal columns. At O are villages in front of the poſition where the army is to encamp, and which have been taken poſſeſſion of by the light infantry.

The number of columns into which the marching army is to be divided, will depend on the number of roads or acceſſible approaches that lead to the poſition which it is to take up. In the preſent caſe there are only two principal roads, each leading acroſs the river, and winding through the valleys to the principal heights, ſo that the army muſt march in two diviſions. The uſual diſpoſition of the columns is as follows, Four or five brigades of infantry, according to the number which compoſes the army, ſhould be placed at the head of each column; the ſame partition ſhould be made with regard to the artillery, which muſt follow the infantry; the cavalry muſt march next, and the baggage of each column, well eſcorted by infantry, muſt follow the cavalry, then the reſt of the corps of light horſe which are not detached; and the dragoons are placed the laſt, in order to diſmount, and ſuſtain the rear guard in caſe it ſhall be attacked.

20
Of the paſſage of rivers.

An army ſeldom proceeds far without encountering a river in its march, and as it commonly happens in a country which has become the ſeat of war, that the bridges are deſtroyed or rendered impaſſable, the army muſt croſs the river, either by ſwimming, at ſome ford, or by temporary bridges thrown over for the purpoſe. It is moſt advantageous to croſs a river at ſome part where the ſtream is divided by ſmall iſlands, unleſs the river be ſo ſhallow that it may be eaſily forded. If it be neceſſary to conſtruct a bridge, this is beſt done by means of boats or pontoons, and all the neceſſary apparatus ſhould be ready at the place of croſſing at an appointed hour, and every meaſure ſhould be taken to avoid confuſion, and to be prepared for the enemy, who will probably diſpute the paſſage. The two heads of the bridge when conſtructed ſhould be entrenched, and well furniſhed with troops, and if poſſible, the iſlands in the neighbourhood ſhould be fortified by proper works, to prevent the enemy from deſtroying the bridge, or incommoding the labourers employed in its conſtruction.

If the river be narrow, it is beſt to croſs at ſome place where it makes an angle, eſpecially if, as commonly happens, one of its banks be higher than the oppoſite bank, ſo that the higher ground may be defended by a battery. If the river be fordable by infantry, care ſhould be taken before hand to clear the bed at the ford, and render the banks eaſy of acceſs.

Plate DXLV. Fig. 2.

The lower figure of Plate DXLV. illuſtrates the paſſage of a river. AAA repreſent bridges of boats; B, redoubts by which the bridges are protected; C, a battery, under cover of which the infantry work at the conſtruction of the redoubts; D, a battery to prevent the enemy from annoying the army on its march; E, the march of the army; F, the artillery diſtributed among the brigades of infantry; G, infantry forming in columns to open on the oppoſite ſide through the intervals of the redoubts; H, march of the columns in the front of the redoubts, where they halt to give time for a part of the cavalry to form upon its flanks; I, a battery erected to facilitate the forming of the cavalry; K, cavalry, which, in gaining the oppoſite ſhore, forms in order of battle, and poſts itſelf upon the flanks of the infantry; L, eight battalions in column upon the right wing of the army, to go and examine the village, and attack the enemy in it, in caſe he ſhould be poſſeſſed of it; M, huſſars and dragoons, who have taken poſſeſſion of the height which is on the left wing of the army; N, a brigade of infantry poſted next the height, covering the left wing of the cavalry; O, the diſpoſition of the army marching up to the enemy.

It is in general a very difficult taſk to defend the paſſage

21
To defend the paſſage of a river.

ſage of a river againſt an army that is determined on croſſing it. Indeed, if the river be of ſuch a nature as to preſent ſeveral points by which an enemy can croſs, and if the defending army be not of ſuch ſtrength as to meet their opponents in the field, ſuch a defence will be almoſt impracticable. Where it can be attempted, however, and where ſufficient notice can be procured of the enemy's approach, all the boats and barks found on the river ſhould be removed or deſtroyed, to prevent the enemy from uſing them in conſtructing his bridges. Both banks of the river ſhould be carefully reconnoitred, that the fords and other acceſſible points of paſſage may be ſufficiently obſtructed; and the ground which might protect the enemy's paſſage, ſhould in particular be attended to. Roads ſufficiently wide to admit of many columns, ſhould be made along the ſide of the river to be defended, that a great number of troops may be advantageouſly diſpoſed. It muſt be confeſſed, however, that if the acceſſible points extend along a conſiderable tract of country, and if the bank of the river next the enemy overhang that on the oppoſite ſide, a defence will be nearly impoſſible.

Fig. 1.

The upper figure of Plate DXLV. ſhews the manner of diſpoſing the troops to defend the paſſage of the river. A, the march of the main army in three parts to defend the river; B, the camp of the light horſe, infantry, and dragoons, on the wings of the army; C, caſtle and village, guarded by light infantry; D, a town occupied by the infantry belonging to the army; E, bridge broken down; F, iſlands occupied by infantry; G, poſts of infantry diſtributed along the ſide of the river; H, batteries eſtabliſhed along the ſide of the river; I, poſts of cavalry, to keep the communication between the camps; K, bridges conſtructed to preſerve the communication of the iſlands; L, bridges for the communication of the camps.

22
Baſis of modern military operations.

Modern warfare is diſtinguiſhed from that of the ancients, not more with reſpect to the arms which it employs, than the multitude of ſtores, ammunition, and proviſions neceſſary for a campaign. The number of horſes now employed for drawing the artillery, and the ammunition waggons, as well as to mount the great increaſe of cavalry, conſiderably adds to the quantity of military ſtores required by the troops. This has produced the neceſſity for magazines, eſtabliſhed in ſuch number, and at ſuch diſtances from each other, as may moſt expedite the operations of the campaign; and theſe magazines require not only to be fortified themſelves, but to be ſtrengthened by forts or redoubts in their vicinity. To theſe magazines modern writers on the art of war have appropriated the term of *baſis of military operations*, and the roads by which an army receives its ſubſiſtence from the magazines, are called *lines of operation*. The ſituation of the principal magazine, and the length and direction of the lines of operation, are conſidered as of the higheſt importance. With reſpect to the firſt and ſecond of theſe, we muſt refer to Templehoff's Hiſtory of the Seven Years War, where the queſtion is conſidered with great minuteneſs and ſcientific accuracy. The direction of a line of operations may be illuſtrated by the firſt ſeven figures of Plate DXLVI. Fig. 1. repreſents a line of operation forming the ſegment of a circle, having a line of poſts ACB towards the enemy's country, and two principal fortreſſes DE within the ſegment. As this circular ſegment is ſuppoſed to ſurround a part of the enemy's territory, and is ſtrengthened by the two fortreſſes AB, at the extremities of the baſis, it is eſteemed the moſt advantageous form. On the other hand, if the ſegment had its circumference directed towards the enemy, as in fig. 2. it would form the worſt poſſible direction for a baſis; for here the fortreſſes CD, placed in the circumference, are very much expoſed, and might be eaſily taken by detachments from the columns E and F. The only way of preventing this would be to detach troops from A and B laterally, to incommode the columns E and F, and to take up a ſtrong poſition either at *g* or *h*. The more the ſegment approaches to the elliptical form, as in fig. 3. it is the leſs ſuſceptible of defence, as is evident from the relative poſition of the three fortreſſes A, C, and B.

Plate DXLVI. Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

The line of operation repreſented by fig. 4. conſiſting of ſalient and obtuſe angles, ſuch as A *c* B, B *d* G, conſtitutes an excellent form, as it reſembles the outworks of a fortreſs, and it is as impracticable for an enemy to enter into the interior of this baſis, as to carry a curtain between two flanks. The two fortreſſes *c d* are not nearly ſo much expoſed as C in fig. 3. as if one of them were attacked, it would be eaſy to make a diverſion from the other into the enemy's country. If the points which terminate the baſis advance as in fig. 5. it will be a favourable circumſtance, eſpecially if the moſt advanced poſt were bounded by the ſea, or by a large river.

Fig. 5.

Fig. 6.

The baſis which we have been conſidering conſiſts of curved or angular lines. Now, let us ſuppoſe two baſes, the one A *h* B, fig. 6. forming merely a ſtraight line, while the other *c e g d f*, has two of its lines *e c* and *d f* advanced towards the enemy. This latter is the more advantageous, as it expoſes ſo much more of the enemy's country. In general, it is a good rule to conſtruct fortreſſes oppoſite to thoſe of the enemy, as here the fortreſs *g*, if moderately ſtrong, is capable of protecting the whole line from *e* to *d*, againſt the three oppoſite forts A *h* B. It is a great fault for any part of a baſis to recede, as *dc* from the line of the enemy AB fig. 7. ſo as to form an angle with it, as here all the country between A and *c* is expoſed to the hoſtile attacks of A and B; but, if the line were parallel to that of the enemy, as *de*, it would be a good poſition.

Fig. 7.

23
Eſtabliſhment of camps.

Next to the eſtabliſhing of magazines, and providing for their ſecurity, and that of the lines by which they are connected, it is of the higheſt importance for a general when he takes the field, to ſelect the proper poſitions where he may encamp his army, ſo as to be readily defended againſt the attacks of a ſuperior enemy, and have an eaſy communication with his own poſts. In ſelecting ſuch a ſituation he muſt be guided partly by the nature of the country, and partly by the ſituation of the enemy; but if poſſible, he ſhould chooſe a poſition which is rather elevated, and which may be protected on the flanks or rear, either by the natural ſituation of the ground, or by works thrown up for that purpoſe. It ſhould not be too near the bank of a river, though it may be of advantage to have ſuch an object in front. The encampment of an army in ſuch a ſituation is pointed out by Plate DXLVII.; where A is the camp of the main body of the army; B, an advanced camp, compoſed of dragoons and huſſars, in order to cover the right of the army, to guard the paſſes by which the enemy might make incurſions upon the flanks and rear of the army, moleſt the convoys, and cut off the communications

Plate DXLVII.

nications ; C, villages and bridges, guarded by the light infantry ; D, poſts of diſmounted dragoons in the front of their camp ; E, poſts of dragoons on horſeback, to ſecure the communication between their camp and that of the main body of the army ; F, bridges built to keep up the communication between the grand and the advanced camp ; G, bridges and villages guarded by detachments of infantry ; H, grand guards of horſe ; I, guards of infantry ; K, bridge, village, and mill, guarded by the infantry belonging to the army ; L, camp of dragoons and huſſars, covering the left of the army, and ſupporting the light infantry ; M, villages and bridges guarded by the light infantry ; N, poſts of diſmounted dragoons in the front and on the flanks of their camp ; O, poſts of dragoons on horſeback ; P, poſts and detachments of huſſars, to patrole in front and on the flanks of the army and their camp.

24
Intrenched camp.

It often becomes neceſſary, either from an inferiority of numbers, or from the nature of the ground, to intrench or fortify a camp. In general this is done by digging deep ditches round the moſt defenceleſs part ; driving palliſades in front of this ditch ; forming an embankment of felled trees, with their unlopped branches pointing towards the enemy ; or, where there is time for ſuch an operation, and where the proper materials can be obtained, conſtructing redoubts or regular outworks, capable of being defended by artillery.

Plate DXLVIII.

Plate DXLVIII. repreſents a camp intrenched in an open country, without any peculiar advantages of defence. A, the main body of the army encamped behind its intrenchments ; B, the camp of the troops of reſerve ; C, camp of the dragoons, to ſecure the rear of the army ; D, camp of huſſars, to cover the ground on the right of the army ; E, villages and redoubts guarded by the light infantry, to ſecure the camp of the huſſars ; F, bridges built to ſecure the communication of the army with the ground on the right, and to favour the retreat of the troops poſted on the oppoſite ſide ; G, brigades of artillery diſtributed on the flanks, and along the whole front of the army ; H, the park of artillery ; I, a bridge entrenched, to ſecure the communication between the army and the ground on the left ; K, villages and farm houſes, guarded by detachments of huſſars and light infantry, to patrole in front of the army.

Plate DXLIX.
Fig. 1.

In Plate DXLIX, are ſhown other methods of intrenching a camp in the neighbourhood of a town or village, and in ſituations where the camp can be protected by inundations. Fig. 1. repreſents an intrenched camp in the neighbourhood of a town. A, a deep marſhy valley, with an unfordable rivulet acroſs it. B, a redoubt conſtructed on a mountain, by which the right wing is *appuyed*. C, a ſmall wood in front of the mountain. D, a line which connects two fleches together at the foot of the mountain, where the village of Weilheim is ſituated. E, a rivulet, over which are thrown bridges of communication, to facilitate an intercourſe between the camp and the redoubt on the hill. F, an eminence with a gentle declivity, at the foot of which is the village of Mansfeld, ſurrounded by defiles and hollow roads. G, defiles and hollow roads. H, lines which run along the circumference of the heights about Weilheim, forming a retrenchment. I, cloſe works. L, a redoubt which maſks the entrance into Stemmern. M, a ſmall wood, cut down in order to have a full view in front of Stemmern. N, a thick wood which covers ſome high mountains by which the left wing is ſupported. O, an abattis which is made acroſs the wood for greater ſecurity. P, infantry pickets. Q, a redoubt on a ſmall eminence, conſtructed for the purpoſe of covering the opening behind the left wing of the camp. R, a line of communication from the laſt redoubt to the left of the intrenchment. S, ſeveral paſſages 30 feet broad and cloſed in by chevaux-de-frize, to afford an opportunity for the cavalry to advance, ſhould the enemy be foiled in his attack againſt any part of the works. T, the infantry and cavalry encamped behind the retrenchment ; the infantry in the firſt line, and the cavalry in the ſecond. U, X, Y, Z, four roads behind the camp to facilitate the retreat of the army, ſhould it be preſſed.

Fig. 2, 3.

Fig. 2. and 3. repreſent an intrenched camp with inundations in front. Fig. 1. *a b*, two dykes 40 paces long, 5 broad, and as many high. CD two rows of ſtakes from 4 to 5 inches thick. E, the coffin formed by means of ſtakes filled up. It is 8 feet broad. F, the adjacent country, inundated by the rivulet being forced out of its current by the laſt dyke and by *a* and *b*. G and H, the outlets which the rivulet ſeeks, to continue its courſe. I, ſmall creeks or ends of ditches dug about the ground. Fig. 3. repreſents the current of a rivulet, with a dyke to occaſion inundations. Camp, with the ſeveral dykes in front, which are calculated to produce inundations. The ſpaces between theſe dykes are called coffins, viz. 1, 2, 3, 4, 5.

25
Conſtruction of redoubts.

We have mentioned the works by which field poſts are fortified, and which are uſually called *redoubts*. As the conſtruction of redoubts is generally a work of the moment, and falls within the province of the commanding officer of a detachment, it is proper that we ſhould here deſcribe the moſt uſeful and expeditious methods of raiſing ſuch works. Theſe methods are illuſtrated by the plans in the upper part of Plate DL.

Plate DL.
Fig. 1.

Fig. 1. ſhows the plan of the ordinary ſquare redoubt which is conſtructed in the following manner : When a proper ſpot has been choſen, a line *a* AE is drawn of a ſufficient length, and at one extremity *a* is drawn *a* C perpendicular to it. Then from *a* towards C and E are ſet off the dimenſions propoſed for each ſide of the parapet within the fort, allowing 2 or $2\frac{1}{2}$ fathoms for 30 men, 4 fathoms for 50, and ſo in proportion for a greater number. Theſe lines being aſcertained, a picket is placed at C, with a cord attached to it, and with the length *a* C is deſcribed an arch, and from the point E, with the ſame diſtance, another arch is deſcribed, interſecting the former in F. Then joining EF and CF, the ſquare forming the inner parapet is completed. Within this ſquare, at the diſtance of 2 or 3 feet, is deſcribed another ſquare I, L, M, N, having its ſides parallel to thoſe of the former. This marks the breadth of the banquette, where the men are to be drawn up. Again, on the outſide of the firſt ſquare at about 8 or 9 feet diſtance is drawn a third ſquare O, P, Q, R, determining the outer ſide and thickneſs of the parapet. This thickneſs is only calculated to reſiſt muſket balls ; as, if it is to ſtand againſt cannon, it ſhould be at leaſt 18 feet. Laſtly, at rather a greater diſtance from this third ſquare is drawn a fourth S, T, V, X, marking the breadth of a ditch that is to ſurround the redoubt.

The lines being finiſhed, *faſcines* or faggots of bruſhwood are to be laid between the two innermoſt ſquares, as a foundation to ſupport the earth of the banquette; a ſecond range is laid on the lines AB, GH, to ſupport the inſide of the parapet, and a third on the ſquare O, P, Q, R, to ſtrengthen the outſide of the parapet, leaving a ſpace through all the *faſcines* to the ditch, on the ſide leaſt expoſed to the enemy, as at B, for an entrance. It is ſometimes convenient to make this entrance take a winding direction, as is ſhown at T, fig. 2.

Fig. 2.
Fig. 3.

Fig. 3. exhibits a ſection of theſe works, where AB is the breadth of the ditch at the top; MN its breadth at the bottom; FN its ſlope, on a line with the outſide of the parapet, called the *ſcarp*, and GM its ſlope towards the open country called the *counterſcarp*. AL and ID repreſent the *faſcines* forming the outer and inner ſlopes of the parapet, the interval between them being filled with earth trodden down hard. At E is the banquette. DC is the thickneſs of the parapet below, and IL its thickneſs above, which forms a ſlope for the more convenient firing of muſketry.

Fig. 4.
Fig. 5.
Fig. 6.

In this ſquare redoubt it is evident that the men muſt fire ſtraight forward in lines perpendicular to the ſides of the ſquares, as in fig. 4. As it is often of great conſequence that the directions of firing ſhould croſs each other, the better to flank the enemy, the banquette is ſometimes formed with angles, as in fig. 5. ſo that the men may ſtand two together in little *redans*. As, however, ſuch a conſtruction takes up too much time and labour for ordinary occaſions, M. Le Cointe prefers a circular redoubt, ſuch as is repreſented at fig. 6. where the men may fire from every part of the circumference. The conſtruction of ſuch a redoubt is extremely ſimple, and differs only in its firſt ſtep, viz. deſcribing the concentric circles, which is done with a cord faſtened at one end by a picket at a central point C.

The ſtrength of the redoubt will be much increaſed, if the ditch can be filled with water, as by turning into it the ſtream of a rivulet. See Q, fig. 7. If the ground be uneven, ſo that the water will not run equally into every part of the ditch, dams muſt be raiſed, as C, to keep up the water in the higher parts, whence it may run to the lower, after the former are full.

Fig. 7.

Fig. 7. repreſents a plan of the ſquare redoubt, with a wet ditch, when completed. A, the inner ground of the redoubt; B, the bottom of the ditch; CDE, the dam of earth; F a dam of boards, planks or faſcines; G the upper part of the redoubt, made with faſcines or with earth thrown out of the ditch; H, the lower part of the redoubt cut into the earth; I, the berme or ſpace left at the outer bottom of the parapet, to keep up the earth; L, the entrance of the redoubt; M, the inſide of the parapet; N, the outſide of the parapet; O, the banquette; P, the glacis; Q, the river introduced to fill the ditch with water.

26
Of detachments ſent to attack or defend a poſt.

The attack and defence of poſts are among the moſt important departments of what the French call *la petite-guerre*, and in a country where fortified towns are rare, conſtitute a conſiderable part of field operations. We ſhall conſider them rather more at large than we have the preceding parts of military tactics.

Fig. 8.

When an officer is detached either to attack or to guard a poſt, he ſhould provide himſelf with a cord regularly divided, for the purpoſe of deſcribing lines, and raiſing temporary works, and ſhould procure a ſkilful and confidential guide, from whom he may derive the requiſite information reſpecting the nature of the country, and the breadth and goodneſs of the roads. He ſhould diſpoſe his party in ſuch a manner that an advanced guard of cavalry, as A, fig. 8. Plate DL, ſhould ſet out firſt, preceded by a ſmall detachment of about ſix horſemen, headed by a corporal, as B, C, C; two horſemen in the middle, and two on each ſide. While the main body is moving along the principal road, as from H to F, a detachment of about 8 or 12 horſemen, according to the ſtrength of the corps, ſhould be ſent about 50 paces on each ſide, by way of wings, as DD; and from each of theſe wings 2 men ſhould keep 50 paces farther out, as at EE, by which means the country will be properly examined, and ſurpriſes from the enemy prevented. On coming near a wood, as at NN, the cavalry ſhould ſpread, the better to ſcour the outſkirts and the wood itſelf. When the corps is numerous, the cavalry ſhould be formed into ſquadrons, as G, G, G, and the infantry into platoons, as F, F, F, marching alternately along the road.

If, on the march, the advanced guard come to a croſs road, or the entrance of a hollow way, as at I, I, where it is likely they may be met by a party of the enemy, they ſhould immediately prepare for an attack; and if the commander of the main body obſerve his advanced guard in action, he ſhould immediately draw off his platoons of infantry, and form them on the ſide of the road, as at L, L, L, or on ſome neighbouring height, as at M, M, that they may be out of the way of the enemy's cavalry, and ready to engage if occaſion ſhould require it.

On the march the party ſhould carefully avoid villages, and rather halt or refreſh his men in a wood, or ſome other concealed ſpot.

27
On reconnoitring.

Plate DLI.
Fig. 2.

The commander of a detached party muſt take the ſafeſt and moſt effectual methods to reconnoitre the country through which he is to paſs, without being obſerved or ſuſpected by the enemy. The method of doing this recommended by M. Jeney will frequently ſucceed, and is as follows: He ſuppoſes himſelf with his party at Soeſt in Weſtphalia A (fig. 2. Plate DLI), and the enemy poſted at Bervick B, two leagues from him. To know the ſituation of this place without ſtirring from Soeſt, he takes the map of the country; and from Soeſt as the centre, he draws a circle, whoſe circumference paſſes half a league beyond Bervick. He draws a circle of the ſame ſize upon a leaf of paper, to make his plan, as in fig. 2. and then places Soeſt in the centre A, and marks all the villages which he finds in the map near the circumference upon his plan, with the diſtances and bearings as they are repreſented in the map, making uſe of a pencil to mark the places DDD, ſo as to correct the errors more eaſily which the map may have led him to make.

Having thus formed his plan, with a ſcale of two leagues, he goes to the burgomaſter of the town of Soeſt, where he cauſes ſome of the moſt intelligent inhabitants to come, and ſpeaking to them freely and openly, induces them to communicate all the information for which he has occaſion.

The better to conceal his deſigns, he begins his reconnoitring by Brockhuſen, a village diſtant from the enemy. He aſks the diſtance from Soeſt to Brockhuſen;

ſen; if they ſay it is a league and three-fourths, he corrects the diſtance of his plan, which made it two leagues; then he informs himſelf of all that is to be found on the road from Soeſt to Brockhuſen, chapels, houſes, woods, fields, orchards, rivers, rivulets, bridges, mills, &c. If they ſay that a league from Soeſt they paſs the village of Kinderking, he marks that place upon his plan. He aſks if the road from Soeſt to Kinderking be croſſed by any other road; if there be any moraſs or heath; if the road be incloſed, paved, or ſtraight; if there be any bridges to paſs, and at what diſtance. He takes care to mark every thing on his plan, forgetting nothing, even to mills, buſhes, gibbets, gullies, fords, and every thing that can be got from their information; which will probably be perfect, becauſe one always knows more than another. He continues his queſtions from Kinderking to Brockhuſen, and advancing by little and little, obſerves the ſame method on the roads of the other villages round, marked DDD. In this manner he cannot fail to acquire an entire knowledge of all the places; beſides, he finds himſelf imperceptibly inſtructed in the poſition of the enemy, by ſeeing the different routes by which he can approach with the greateſt ſecurity.

28 Attack of poſts. For the attack of an enemy's poſt, ſuch men ſhould be ſelected as are brave, cool, and experienced; or if the affair require a conſiderable number, the detachment ſhould be divided into platoons, ſome compoſed of picked men for the real attack, and others of ordinary ſoldiers for feints. The men ſhould be provided, beſides their arms, with ſuch inſtruments as may be neceſſary for pulling down or ſcaling the enemy's works, ſuch as ſhovels and pickaxes for faſcine parapets; hatchets or palliſadoes, for chevaux de frize, and ſcaling ladders for ſtone or brick work. Having made the proper diſpoſition for his attack, and procured the neceſſary guides, the commander of the detachment ſhould ſet out in the night, ſo as to be at the place of attack two or three hours before daybreak, taking care to march with as little noiſe or parade as poſſible.

If the poſt to be attacked be an ordinary redoubt, ſuch as we have deſcribed in N° 25. on hearing the ſignal previouſly agreed on, all the diviſions are to riſe at once from the place where they ſhould have lain concealed; the firſt ranks ſhould leap into the ditch, and ſoon after the ſecond ſhould follow, and both together aſſiſt in undermining the angles of the ſcarp, or cutting away the ſtakes which may impede their progreſs. If the parapet be faced with ſtone or brick work, care ſhould be taken that the ladders be not too ſhort, and great expedition ſhould be uſed in mounting them, and eſpecially in following the leading men in the aſſault, if they ſhould be knocked down by the fire of the enemy.

Should the ditch be filled with water, and too deep to be waded, it may be croſſed on temporary bridges made of planks, ſupported on empty caſks, or the ditch may be filled up with caſks full of earth. If, as often happens, the ground be obſtructed with caltrops, theſe muſt be ſwept away by dragging trees with their leaves and branches over the ground (A).

In attacking poſts of conſiderable magnitude, ſuch as villages, it is beſt to divide the attack, and to make a feint on thoſe parts which ſeem beſt defended, while the true attacks are reſerved for thoſe ſituations which ſeem moſt difficult of acceſs, and where conſequently, the enemy is leaſt upon his guard. As ſoon as part of the village has been carried, ſome diviſions of the detachment ſhould haſten to ſtrengthen their poſition, by poſſeſſing themſelves of ſome church, or high ground, from which they annoy the enemy.

29 Defence of poſts. When a poſt is once occupied, if it be thought of ſufficient conſequence to retain it, the beſt methods ſhould immediately be taken to protect it againſt an attack of the enemy. The infantry to remain under arms in the middle of the place, the cavalry to patrole without, while the commanding officer, eſcorted by a dozen horſemen, goes to examine the environs to make his arrangements; having ſent ſeveral ſmall detachments before, to cover him in time of reconnoitring.

Having remarked the places proper for his guard, defence and retreat, as well as the dangerous ones by which the enemy can make approaches ſecretly to ſurpriſe him, he ſhould chooſe the moſt convenient in the front of his poſt to fix his grand guard D, (fig. 1. Plate DLI.), which muſt face the enemy. He muſt mark the heights for this guard to place their vedettes EEEE, and regulate the number according to the exigencies of the ſituation. In a covered country you muſt not be ſparing of them, and muſt reinforce every guard. At 50 paces from the front of the grand guard a noncommiſſioned officer with eight horſemen ſhould be always ready to ſet out at K, to go and reconnoitre, when the vedettes have obſerved any party. Plate DLI. Fig. 1.

If the poſt to be defended be merely a redoubt, it will be proper to keep in readineſs a number of trees cut down with their branches, to ſtop up any breaches made by the enemy's ſhot. The men employed in the defence ſhould ſtand in three ranks, the front and centre ranks with fixed bayonets, and the third rank provided with long pikes, ſo as to project as far as the bayonets of the front rank. On the enemy's approach, the men ſhould reſerve their fire till the enemy come up to the glacis, and the rear rank ſhould be furniſhed with hand grenades, or lighted faggots, to throw among the enemy, when they attempt to ſcale the parapet.

In the defence of a village or ſmall town, guards ſhould be poſted at the entrance of the principal ſtreets; trenches ſhould be cut acroſs the ſtreets, and cannon planted behind them, while a detachment of cavalry ſhould occupy the market place, or broadeſt ſtreet, to attack the enemy, if they force an entrance. If the advanced guards are driven in, they ſhould retire with coolneſs and deliberation, defending their poſts from houſe to houſe, till proper ſupport can be given them from the body of the detachment.

If there be any dangerous place capable of covering the approaches of the enemy in the environs of the poſt, and

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(A) The principal engines employed in the attack of poſts, are repreſented in Plate DLV. to which we ſhall preſently refer.

and out of the circuit of the patroles, there ſhould be a guard placed there, more or leſs ſtrong according to the importance of the place, and care ſhould be taken to preſerve the communication. The guards and picquets being placed, the detachment that was ſent out on the roads muſt be called in, and then go to work to lodge the party in the gardens that open upon the country, and the commanding officer's quarters; beating down hedges, filling up ditches, and levelling a piece of ground large enough to draw up the whole corps. The horſes to be put under cover in barns contiguous to the gardens; but in caſe there are no barns, they may ſubſtitute ſheds open on one ſide, that the horſes may go out together in caſe of an alarm. The officers ſhould occupy the houſes in the neighbourhood of the ſheds, and one of each company remain day and night with the company, to prevent any of the men from entering the village without leave, upon any pretence. The commanding officer muſt acquaint the officers of his having choſen the place M for the rendezvous in caſe of a retreat; which ought to be at ſome diſtance from the village, and on the ſide he judges moſt convenient for retiring to the army. At ſunſet the grand guard are to return to the poſt and join the picquet, the half of each to mount alternately till daybreak, and then the grand guard to return to the place which they poſſeſſed the day before. The ſentries and vedettes ſhould be doubled, and all the paſſages ſhut up with waggons placed in two rows, except one for ſallying out at in caſe of a retreat, made wide enough for the paſſage of the patroles or the whole cavalry.

The corporals of the ordinary guard ſhould lead the relief of the vedettes every hour, ſetting off together; but when they come to the paſſage of the poſt A, they muſt ſeparate into two parties, the one to the right to relieve the vedettes BBB, the other to the left for the vedettes CCC; then each of them with the parties they have relieved ſhould go on at their head a quarter of a league by the two routes pointed out in the plan, to examine the environs, ſuppoſing an hour to each. Beſides this reconnoitring, the captain of the grand guard ſhould ſend two patroles in the night. To fill up the intervals, they ſhould ſet one about half an hour after the corporals, and make the ſame round.

30
Mode of fortifying villages.

In defenſive operations in an open country, the fortifying of a village or a church-yard may often prove of importance, as ſuch poſts well defended may obſtruct the movements of the enemy, and give time for a ſufficient force to collect to meet them in the field. We ſhall therefore deſcribe the moſt approved mode of ſtrengthening theſe poſitions.

When it is propoſed to fortify a village, inquiry ſhould firſt be made reſpecting the ſurrounding country, whether there are woods, hills, or rivers near the village, whether the roads be acceſſible, whether proviſions can be eaſily obtained, &c. If the village is to be occupied as a poſt of defence merely, the woods, rivers, ravines, or heights, may afford advantageous outpoſts or ſituations for batteries or ambuſcades; but if it is to be poſſeſſed as an advanced poſt on the eve of a battle, the woods next the army ſhould be cut down, the hollows filled up, and every thing removed which may obſtruct the freeſt communication between the village and the main army; while on the ſide of the enemy, every obſtruction by works, trees, &c. ſhould be thrown in the way of his approach. The roads ſhould be broken up or interſected with deep ditches.

If there be good hedges or deep roads parallel to the village, or in ſuch a ſituation as to front the enemy, theſe will ſerve as breaſtworks, and for ſhelter. The hedges ſhould be cut down to within four feet of the bottom, their tops ſloping towards the country, and deep ditches ſhould be dug in front. If the roads are deep, *banquettes* or *ſteps* muſt be thrown up next the hedge to raiſe the men to the proper height for firing. For want of ſuch natural means of defence, it will be neceſſary to throw up intrenchments on the ſide next the enemy and on the flanks.

Plate DLII. Fig. 1.

Fig. 1. Plate DLII. will explain the method of doing this in a village, under ordinary circumſtances. The village ſtands in a plain, and in front of the army, which is diſtant from it about 600 paces, *a*. The front of the intrenchment conſiſts of three fleeches or arrows, *b*, *c*, *d*, joined together by lines. There are wolf-holes before the works that cover the left flank *e*: the line *g*, which croſſes ſome ſwampy grounds, is broken in ſeveral places *i*; and the grove of wood *l*, is cut down, to prevent the enemy from approaching under cover of it. As the right flank, conſiſting of a level plain, is more expoſed than any other quarter, in addition to the works made of earth, which are thrown up at *m*, trees are collected, and heaped up in the form of an abattis, *n*. Theſe are defended by a diſcharge of muſquetry from the intrenchments, whoſe lines are raiſed as high as poſſible behind the growing hedges *o*, which incloſe the gardens. It has however been judged neceſſary to throw the works up in a forward poſition *p*, and to have an interval between them and the hedges, leſt the houſes ſhould be ſet on fire by the enemy, and the troops be expoſed to it. Every thing is left clear and open at the back of the village, in order to ſecure a free intercourſe with head-quarters.

Other meaſures, however, muſt be adopted in the fortifying of villages which lie at ſo great a diſtance from the camp, that the enemy might ſurpriſe and take poſſeſſion of them before any ſuccours could be ſent; for in that caſe, intrenchments muſt be thrown up throughout the whole of their circumference. If, on the contrary, one of the wings of the army ſhould be ſupported by ſuch a poſt, it would be more judicious to put the flank in a ſtate of defence, and to lengthen the works in that quarter, to prevent the enemy from turning it.

If it ſhould be judged expedient, under the circumſtances of the army being cantoned, to fortify a village which lies in a plain, other means muſt be uſed; for in that caſe there would not be troops enough to defend it. Should there be a ſufficiency of men, intrenchments muſt be thrown up in the manner we have deſcribed, and fleeches muſt be adopted to cover them behind, with lines to connect the vacant intervals; but if there be a ſcarcity of ſoldiers, nothing but what is abſolutely neceſſary muſt be done; for it is highly impolitic to attempt more than can be eaſily defended. Under theſe circumſtances you muſt be ſatisfied with erecting ſmall works, or uſing barricadoes to maſk the entrances; here and there likewiſe fleeches muſt be conſtructed, whoſe communication will be kept up by the garden hedges. If the village ſhould ſtand on an eminence, it may

may be fortified with more facility, and many things may be omitted, as the natural ſituation is itſelf a reſpectable poſt.

Should there be a very great diſproportion between the extent of the village, and the number of men intended for its defence, and the latter ſhould be too ſmall, a part only muſt be fortified, and the remainder of the houſes muſt be ſecured by lines. Sometimes indeed it is found neceſſary to burn or deſtroy them, to prevent the enemy from approaching the fortified parts, under cover of the buildings.

But if the garriſon ſhould not be ſufficiently ſtrong even to defend a part of the village, you muſt be contented with fortifying the church and church-yard, or the caſtle, if there be one. If any of theſe poſts be thought defenſible, troops muſt occupy them on the firſt alarm; but this muſt be done in perfect ſafety, and without the ſoldiers being expoſed to be cut off on their march. This precaution is above all others neceſſary where villages are ſo long and open that the cavalry may enter them at every opening. On this account the ordinary roads and avenues muſt not only be obſtructed, but the garden hedges muſt be repaired, and every opening muſt be cloſed, which may be eaſily done by driving ſtakes into the earth, and nailing boards acroſs them, which will prevent any ſudden irruption of the cavalry, from which alone any danger is to be apprehended on occaſions of this ſort; for the infantry would ſcarcely advance, except by ſurpriſe, before the garriſon could occupy its ſtation. If any apprehenſions are formed of an attack, the ſoldiers muſt not be abſent from their poſt, either in the duſk of the evening, or at night; they muſt, on the contrary, be aſſembled in the intrenchments during that period, to be ready in the neighbouring houſes, always clothed and accoutred.

31
Method of fortifying a church and church-yard.
Fig. 2. & 3.

A church and church-yard afford an admirable poſt of defence, eſpecially if, as uſually happens, they are ſeated on an elevation. In fortifying ſuch a poſt, we ſhould firſt block up every road and bye way leading to it, by means of waggons or carts, with their wheels taken off and loaded with dung or earth; trees laid acroſs, or chevaux de frize. The narrow paths may be barricadoed with rails, with their points ſtanding upwards, and a little outwards, having behind them thick branches of trees, or logs of wood, with a ditch in front. Theſe previous precautions being taken, the doors of the church ſhould be pierced in ſeveral places, about eight feet from the bottom, with holes large enough to admit the muzzle of the muſquet, and platforms ſhould be raiſed with ſteps within for the men to fire from. Other loop holes ſhould be made at the bottom of the doors, juſt above the level of the ground, and a ditch muſt be dug within, about three feet deep, ſo as to admit of men firing from thence through theſe lower loop-holes. See fig. 2. The doors muſt alſo be ſecured by barricadoes, conſiſting of palliſades driven ſeveral feet into the ground, and ſet extremely thick, ſome being deeper than others, ſo as to leave ſpaces between them and the top for loop-holes. See *a a*, fig. 3. This barricado is technically called *tambour*. The walls of the church muſt alſo be pierced in various places as directed for the doors, ſee fig. 3. and ditches muſt be dug within them, and ſcaffolding erected as before.

Again, on the outſide of the church, a ditch is to be dug as cloſe to the walls as is conſiſtent with ſafety to the foundation, about 12 feet in breadth at the top, and four in depth; and from the further ſide of this ditch the ground ſhould be gradually ſloped towards the open country. Through the main door of the church an opening ſhould be made about two feet above the ground, ſufficiently large to admit of one man paſſing through without much difficulty, ſo that when the church-yard becomes untenable, the garriſon may retreat into the church.

It muſt not be forgotten to ſecure the means of a croſs fire. If the church be built in the form of a croſs, croſs firings may be eaſily procured through the proper loop-holes; but when this is not the caſe, loop-holes ſhould be made through every ſalient angle of the building, or tambours, ſuch as repreſented in fig. 3. muſt be formed wherever it can be conveniently done.

Men muſt be diſtributed in the upper part of the building. Theſe men will take out the tiles or ſlates in different places, in order to obſerve the approaches of the enemy, and to fire upon him when he comes within muſket-ſhot. The lower windows of the tower or ſteeple muſt likewiſe be barricadoed, and have loop-holes made in them. The pavement of the church muſt be taken up, and the ſtones or bricks be carried to the top of the building, to enable the beſieged to let them drop upon the enemy, when he gets ſufficiently near. In order to render the defence as practicable as poſſible, you muſt alſo collect ſome large barrels or tubs, and keep them conſtantly at hand filled with water, for the purpoſe of extinguiſhing any fire which might break out in the church, or be effected by the enemy's ſhells.

Fig. 4.

Fig. 4. ſhows a plan of the church and church-yard thus fortified. *a*, *a*, *a*, *a*, the wall of the church-yard; *b*, *c*, tambour work in front of the entrances; *d*, the church; *e*, *f*, tambour work conſtructed oppoſite the doors; *g*, the ſacriſty or veſtry.

32
Of ambuſcades.

Connected with the attack and defence of poſts is the ſubject of ambuſcades, which we muſt now briefly conſider.

Aambuſcads may be formed in any place where a party may lie concealed, to ſurpriſe the enemy in paſſing. They are eaſily carried into execution in woods, hollow places, and large deſerted buildings; but the placing of an ambuſcade in any ſituation requires previous accurate information with reſpect to the movements of the enemy. When the commander of a party has been directed to form an ambuſcade, to ſurpriſe a convoy of artillery, baggage, or proviſions, or a body of recruits going to reinforce the enemy, he ſhould firſt make every neceſſary inquiry reſpecting the route which the enemy is to take; the ſituation of the places near which he is to paſs, and the poſt to which he is about to march. He muſt alſo inquire with ſeeming anxiety about the roads which lead in an oppoſite direction, on which he ſhould ſeem more intent than on his main object. Having concerted his plan, he ſhould ſet out at the head of his detachment if poſſible, and leaving his poſt on the ſide oppoſite to his true route, the better to conceal his deſign. If the place where he intends to plant his ambuſcade be not far diſtant, he ſhould come into his true route about half way, and there place halt his infantry in ambuſh to favour his retreat. But when the country where he propoſes going is diſtant, and the

march

march requires at leaſt two nights, he muſt conduct his party by meandring from wood to wood, if there be any. He muſt not forget to provide neceſſary refreſhments for the day, which muſt be paſſed in ſome concealed place where he may not be perceived, and muſt cauſe three rations of oats to be carried for each horſe.

Proper precautions having been taken to guard any croſs road or bridge that may lie near the place of ambuſcade, the commanding officer ſhould take care to be at leaſt two hours before the enemy, and to place the ambuſcade on that ſide, by which, if worſted, he may retire with the greateſt ſafety.

Plate DLIII. Fig. 2.

Plate DLIII. fig. 2. will illuſtrate the proper method of laying an ambuſcade. A repreſents the infantry of the ſurpriſing party, which ought to be placed at leaſt 600 paces behind B, the cavalry, ſo that, if purſued, they may both fall back to A, and make good their retreat to the guard at the bridge or croſs road; or to another party of infantry placed in ambuſh half way. If the ambuſcade be placed in a wood, an intelligent non-commiſſioned officer ſhould be choſen to get upon a high tree C, from which he can ſee the march of the enemy, and give notice of the moſt eſſential circumſtances. The firſt of theſe is the ſeeing the advanced guard; the ſecond is the approach of the corps, and the third is the time when their front is advanced as far as the ambuſcade B; for which the commanding officer ſhould inſtruct the obſerver what ſignals he is to make from the top of the tree, to communicate the neceſſary information without ſpeaking, which may be done by means of a ſmall cord D, of a brown or green colour, ſo as to be leaſt perceptible. Let this cord be placed as in the plan, ſo that no branch interrupt it, with one end in the hand of the obſerver, and the other in the commanding officer's hand in the ambuſcade B.

As ſoon as the advanced guard appears, the obſerver muſt pull the cord, and the commanding officer cauſe the party to mount and remain in deep ſilence. If by a ſtratagem, which is practiſed for particular reaſons, the advanced guard is immediately followed by the corps, which may be eaſily known by their being more numerous than ordinary, and not followed by any other corps, that the commander may not be deceived by the enemy, the cord ſhould be drawn a ſecond time, and a third time when their front is advanced as high as the ambuſcade. At that inſtant the party muſt ruſh out, and furiouſly attack the flanks of their centre in the following manner.

If the advanced guard E is formed only of an ordinary number, they ſhould be allowed to paſs; and at the approach of the principal part or convoy F, the chief to be informed by the ſecond pulling of the cord. At the moment the head of the convoy ſhall be advanced as high as B, the cord muſt be pulled the third and laſt time; and at this ſignal the party muſt ruſh out without being perceived, and ſuddenly attack the centre on the flank, engaging only with their ſwords, and making ſuch a noiſe as to prevent the enemy from hearing the orders of their officers. They muſt diſarm all whom their bravery ſhall throw in their way, taking care not to ſcatter or purſue too far, unleſs it be certain that they are ſo far from their army or parties, on account of which they cannot be affected; for in either of theſe caſes they will not fail to run at the noiſe, and diſturb the retreat.

In all ſecret expeditions, great circumſpection ſhould be uſed, that the party be not ſeen or betrayed; as if they be diſcovered by the advanced guard before the blow be ſtruck, the enterpriſe muſt be immediately abandoned, and the party retire. When the guide, or any one of the party deſerts, and cannot be catched, a retreat muſt immediately be thought of, or the ambuſcade muſt be placed ſomewhere elſe; but to prevent ſuch a misfortune, the officers ſhould be charged to examine frequently whether they have all their men.

An ambuſcade ſhould never be formed for cutting off the enemy's retreat, as this will drive him to deſpair, and make him rally and attack the party with deſperate reſolution. There may be an exception to this, when it is pretty certain that the whole party of the enemy may be cut off or taken priſoners, either from the ſmallneſs of their number, or from the peculiar ſituation of the place of ambuſcade.

Several ambuſcades ſhould not be formed at once, except for the purpoſe of ſeizing foragers, in which caſe they ſhould be diſpoſed ſo that the ſentinels may ſee from one to another. Then the firſt guard which ſees the foragers, ſhould commence the attack, and can ſoon be aſſiſted by the reſt of the party.

In all ambuſcades, no ſentries ſhould be placed but officers or non-commiſſioned officers. On downs, behind mountains, or in gullies, the ſentries ſhould lie with their bellies on the ground, and their feet towards the ambuſcade, the body covered with a gray or green cloak, according to the colour of the ground, with their heads a little raiſed and wrapped in a handkerchief of ſtraw green colour, or white in time of ſnow, ſo as not to be eaſily perceived. The number of ſentinels cannot be determined, but they ſhould be diſpoſed ſo as to watch on all ſides of the ambuſcade, and ſtop every one who may inadvertently approach too near. The ſentries ſhould give notice of what they diſcover by geſtures, to which all the officers ſhould be very attentive. In countries where there are no woods, vineyards, or hedges, an ambuſcade may be placed in a field of hemp or corn, or ſome ſort of grain, provided it be high enough to cover the men, at leaſt with the help of art. When the ſtalk of the corn is not high enough, ſome of the infantry muſt be ſet to work with ſpades and pickaxes, which they muſt have brought along with them, for the purpoſe of digging holes in the field deep enough to make up for the defective height of the corn.

Fig. 1.

An ambuſcade often forms part of a ſtratagem for bringing on an action with a party of the enemy which would be ſuperior, were it not for ſome advantage of this kind, as in the following caſe. See Plate DLIII. fig. 1. Suppoſe the whole party to ſet out from A, marching under the conduct of a truſty guide by covered ways at a diſtance from the enemy. Being come to the place C, which ought to be in the environs, and as high as the field of battle, the infantry ſhould be concealed out of the road far from the ſight of paſſengers. This muſt be the centre of correſpondence with the army; the rendezvous of the booty, and ſupport the retreat of all the cavalry, of which there ſhould be as many detachments as there are attacks propoſed to be made. We ſhall ſuppoſe ſix of 100 men each, and they muſt

muſt go ſecretly by particular routes to their reſpective poſts, E, D, F, G, H, I. Neither trouble nor expence ſhould be ſpared to procure good guides. Each detachment ſhould lie in ambuſh half a league, if neceſſary, from the object of the attack BKKKK.

The noiſe of the muſketry in the armies is to be the ſignal for their irruption; and then bravery, intrepidity, and courage will give wings to the people. The ſecond detachment D will glance imperceptibly between the villages, and fall like thunder on the camp B; and while 80 attack all whom they meet, the other 20 ſhould light their torches at the fires that are to be found everywhere, and ſpread the flames rapidly to the ſtraw of the tents. As they cannot fail to have the picquet of the camp ſoon at their heels, they muſt ſtrike their blow with all poſſible expedition, without ſtopping to plunder, being content with the glory of having excited a general alarm, capable of confounding the whole army, and contributing to the gaining of a battle.

At the ſame time that the detachment D attacks the camp B, the others, E, F, G, H, muſt with equal violence attack the villages K, K, K, K, which they have in front, doing the ſame the firſt did in camp, except that they may ſeize as plunder every thing which they can conveniently carry off, with which theſe villages are commonly filled, ſeizing the beſt horſes, hamſtringing others with the ſtroke of a ſword, and ſetting fire to all the places which contain the enemy's baggage. Each detachment ſhould cauſe ſome horſemen to advance beyond the village, to obſerve the motion of the troops, who will not fail to run to their aſſiſtance. As ſoon as they perceive them, they muſt make their retreat as faſt as poſſible by the routes which the commanding officer has preconcerted, and which are repreſented in the plate by the coarſe lines. The ſixth detachment I, in ambuſh on the ſide of the road leading from the camp, ſhould remain there, to ſeize all the enemy who think of ſaving themſelves by flight.

33 Of retreats. When the commander of a detachment finds himſelf obliged to abandon a poſt, or that it is not worth defending, it becomes neceſſary for him to prepare for his retreat. This is often a difficult and dangerous affair, and requires much prudence as well as bravery on the part both of officers and men. If poſſible, he ſhould retreat on that ſide which forms a communication with the general baſis or line of poſts occupied by his party. The following obſervations on lines of retreat, connected with the lines of operation deſcribed in N° 22, will be found of importance.

Plate DXLVI. Fig. 8. A retreat on a ſingle line is a fault of the utmoſt magnitude, for it is evident that if the army C (fig. 8. Plate DXLVI.) retire from it towards B, along the line AB, the enemy may ſend beſides, two corps *a*, *d*, againſt the flanks of this army, which would ſeparate it at the point B, and in this caſe it would be ſurrounded. Nor is this the only diſadvantage, for all the country ſituated to the right and left of the line AB, would fall into the hands of the enemy; while, in a retreat, it is always a rule to cover as much of the country as poſſible.

Fig. 9. Fig. 10. A concentric retreat is of ſuch a nature, that in an extenſive poſition they fall back to one more confined, ſo that the two lines of operation at the extremities AB, (fig. 9.) unite at the object of retreat C, forming an acute angle, or as at fig. 10. an obtuſe angle; ſuch a retreat would have no better iſſue than the former. The ſame diſadvantages which reſult from retreats on a ſingle line would likewiſe attend this. There is one circumſtance which might induce a general to retreat in this manner, and that is, with the view of covering any important place, a capital, for example, by taking an advantageous poſition, which is indicated by C, in the figures; the important place required to be covered would probably be at D. But nevertheleſs this meaſure would be ineffectual if the enemy were at all verſant in the art of war, and operated on the flanks of the army they were purſuing. The beſt method of covering a country, which is in our rear, is to proceed againſt the flanks of the enemy which is advancing; and by this intrepid and bold movement, to change our defenſive operations into thoſe of an attack.

Fig. 11. A retreat conducted in parallel lines, as the baſis AB, in four corps, 1, 2, 3, 4, or the lines AC, EG, FH, BD, is doubtleſs better than the concentric retreats which we have juſt conſidered. In the firſt place, the country is better covered by means of the parallel lines; ſecondly, the enemy cannot ſo eaſily inſult the flanks of the retreating army, provided that this is in a condition to perform the ſame manœuvre with regard to them, and thus obſtruct their progreſs; laſtly, they would be afraid of advancing with too much precipitation, from the moment their attention is divided by the attempt which may be made againſt them. But there might be ſomething ſtill better attending it, viz. to retire in an eccentric direction, as we ſhall ſhow preſently.

The excellence of parallel retreats is maintained from the idea that they cover a country better, and likewiſe ſtop the progreſs of an enemy, when oppoſed in a direct line. Certainly this appears evident to the eye; but the ſight is often the medium only of error. It is the *ignis fatuus* which leads us into the mire, and the preſent inſtance is a proof of it. This opinion was not indeed well founded among our predeceſſors, and ſtill leſs is it ſo among the moderns. We do not now arreſt the progreſs of the enemy, by preſenting ourſelves to their ſtrongeſt part, viz. their front; but on the contrary, by intercepting their flanks, which are the weakeſt parts; by haraſſing their rear; by menacing their proviſions and their communication with the ſources of their vigour and power. It follows from hence, that eccentric retreats are the beſt. An army (fig. 12.) who retires from *a*, *b*, *c*, *d*, *e*, towards *f*, *g*, *h*, *i*, *k*, runs no riſk of ſeeing the enemy advance in the ſegment *f*, *k*; for he would, by ſuch a movement, be in danger of being ſurrounded.

We may lay it down as a rule, that it is eſſentially neceſſary, in all retreats, to divide into different columns, in order to divert the attention of the enemy; and it is fully demonſtrated that there is not in war a more important maxim. We might ſhow that this method of attracting the attention of the enemy to many different points at once is, properly ſpeaking, exciting a degree of apprehenſion with regard to his flanks and rear. But it naturally reſults from all that has been ſaid relative to the inutility of diverging offenſive operations, as well as thoſe which are directed by a ſingle line, or by an acute angle, that eccentric retreats are of all others the moſt preferable. Since concentric operations are the moſt advantageous in attacking, eccentric ones muſt neceſſarily poſſeſs the ſame advantages in defence; every thing ſhould be in oppoſition, in two different kinds of warfare, which are in their nature and intereſts contradictory.

In conducting a retreat, as in all other field operations, an army ſhould aſſume, as the principal object, its own magazines, and the ſafety of its lines of convoy, rather than the army of the enemy; and it ſhould never take a poſition oppoſite the enemy, but rather on one ſide of him.

34
Of battles.

We have hitherto conſidered military operations in the field, as they are ſubſervient, or preparatory to, that moſt important conſequence of war, a *battle*. We muſt now examine what are the cauſes which ſhould induce a general to hazard or avoid a battle; and if he determine on a general action, what are the beſt methods of diſpoſing the troops under his command.

At preſent, actions in the field are diſtinguiſhed into two kinds, according as they are more or leſs general. When the whole of the adverſe armies are engaged, it is called a *battle;* but where only a part of each is concerned, a *combat*. The latter of theſe, however deſperate, does not in general involve ſuch important conſequences as the former; but as in a general engagement, the vanquiſhed party uſually loſe the greater part of their artillery and baggage, and are compelled to retire and leave the country behind them at the mercy of the victors, a prudent general never hazards ſuch loſſes without important reaſons.

35
Reaſons for hazarding a battle.

When an army is ſuperior to its opponents in number or diſcipline; when diſcord prevails among the chiefs of the adverſe army; when a neglect of the ordinary precautions in marching, encamping, or other obvious duties, demonſtrate their incapacity; when it is neceſſary to relieve a conſiderable town or poſt that is beſieged by the enemy; when it is apprehended that the army will be diſperſed or ruined, without a general engagement; when intelligence has been received that reinforcements are approaching to the enemy, which will render him ſuperior; when the enemy has received, in ſome preceding action, a conſiderable check which he has not yet recovered, or when the army whoſe general is thus canvaſſing the advantages and diſadvantages of a battle, is in ſuch a ſtate, that every thing ought to be hazarded for its relief, the commander is warranted in giving battle to the enemy.

36
Reaſons for avoiding a general action.

On the contrary, when leſs is to be hoped for from a victory than feared from a defeat; when the army is inferior either in number, courage, or diſcipline, to the enemy; when it is in expectation of being reinforced by a ſtrong detachment of freſh troops; when the enemy is ſo advantageouſly poſted that it would be impoſſible to bring him to an engagement on equal terms, or to force his entrenchments; or when there is a proſpect, by temporiſing and declining battle, of ruining the army of the enemy by diſeaſe, famine, or deſertion, it would be wrong to place the fortune of the campaign on the iſſue of a battle.

37
Preparation for a battle.

When a general engagement has been reſolved on, the general is to deviſe the means of carrying it into execution, ſo as to have the ſtrongeſt preſumption of ſucceſs. He is to arrange, with the officers of his ſtaff, the manner in which the troops are to be divided and diſpoſed, or what is called the order of battle; he ſhould aſſign to his ſeveral officers their reſpective poſts, and ſee that copies of the order of battle be given to thoſe that have a ſeparate command. The proper officers ſhould take care that the troops under their command be properly armed and equipped, and that they are allowed time to reſt and refreſh themſelves before the engagement. The heavy baggage, and every thing that might encumber the operations of the troops, ſhould be removed, and placed at a diſtance under a proper guard. A reſerve ſhould be formed near the park of artillery, conſiſting of ſome of the braveſt and beſt diſciplined troops, headed by the moſt experienced officers.

38
Circumſtances to be attended to during the action.

In time of action, the commander in chief ſhould be ſo ſituated as to be able to iſſue his orders with the leaſt difficulty, and to obſerve as far as poſſible the operations of his troops, and more eſpecially the effects of the firſt attack. Every other general officer muſt keep his own ſtation, to direct the charge of the troops, or to rally and re-form thoſe which have been routed and diſperſed. When the action becomes general, and is obſtinately conteſted, the commander-in-chief ſhould direct the principal efforts of his troops againſt that part of the enemy's line which makes the greateſt reſiſtance, and ſhould himſelf haſten to this ſpot, to animate his men to greater activity and exertion by his preſence and exhortations.

The artillery of the army ſhould accompany the firſt line, and the remainder of the troops ſhould follow the movements of thoſe before them, ſo as to preſerve the proper diſtance between the lines, and march with the leaſt poſſible diſorder and confuſion. If the firſt line give way, the ſecond ſhould march up to its relief, and either charge the enemy, or keep him employed till the firſt line has time to rally and re-form. If, however, as often happens, the other lines are ſtruck with a panic on obſerving the repulſe of their predeceſſors, the reſerve ſhould be brought up, and it is probable that their courage and reſolution will reanimate the ſcattered troops, and turn the fortune of the day.

39
Order of battle.

In forming the order of battle, regard muſt be paid to the nature and ſituation of the place where the battle is to be fought; to the number and quality of the troops engaged, and to the mode of fighting which is moſt likely to take place during the action, or to decide the victory. There are two principal methods of forming troops in order of battle, the column and the line. The former of theſe was moſt in uſe among the ancients, has been greatly recommended by Folard in his commentaries on Polybius, and practiſed with the moſt brilliant ſucceſs by the French armies ſince their portentous revolution. This order of battle is adapted chiefly to caſes where the activity of the troops can be relied on, and where much firing with muſketry or artillery is not expected to take place, and where of courſe the affair is to be decided principally by the pike or the bayonet. It is alſo well calculated for a body of infantry who are to reſiſt the attack of cavalry. It is obvious that from the cloſe arrangement of troops in column, this diſpoſition muſt expoſe them more to the fire of a line, and muſt endanger their being flanked or ſurrounded by an enemy whoſe front is more extended. The relative advantages and diſadvantages of the column and the line, will be more readily perceived by attending to the following principles.

From the order of battle as a baſis are deduced many inſtructive

inſtructive principles relating to what are called *lines of marching* and *lines of firing*, which conſtitute a conſiderable part of the elements of modern tactics.

40
Principles of marching and firing, deduced from the order of battle.

There are as many lines of marching ariſing from the order of battle, as there are ſoldiers in the firſt rank of the line or column, and as the ſoldiers approach towards the enemy, theſe lines of marching, at leaſt in the infantry, produce lines of firing. It is the nature and relative advantages of different lines of marching and firing that we now propoſe to conſider.

Plate DXLVI. Fig. 13.

Let us ſuppoſe two lines of troops, A and B, fig. 13. extended oppoſite to each other, of which A is conſiderably longer than B at each extremity, or, as it is termed, outflanks it. It is evident that B may be ſurrounded by A, as from the ſuperior numbers of A, B may be attacked in flank and rear. It is therefore evident that when the numbers are unequal, and the conteſt is to be decided by firing, the greater number muſt prevail, if both are arranged in lines.

Fig. 14.

Again, the line AB (fig. 14.) being attacked by the line *c d*, the flank B cannot extend itſelf parallel to *c d*, if this line advances always in front towards A. The line attacked is ſurrounded, and even ſo preſſed upon, that they muſt all take flight towards A. If any troops by chance ſhould endeavour to form upon the line *e f*, they would not have time; taken in front and in flank by the enemy's fire, they could never reſiſt ſuch an attack. The cavalry would experience the ſame diſadvantages in a ſimilar caſe. Horſemen attacked to the right, to the left, and in front, could not defend themſelves; the celerity of the horſes, no doubt, would enable them to deploy quicker than the infantry; but, by the ſame reaſoning, the enemy's cavalry, which is advanced upon their flank, would likewiſe advance the quicker from the point B, towards the oppoſite wing A, which a corps of infantry could not poſſibly do. Thus it would be equally difficult to form the line *e f*; everything would be overthrown, and they muſt retire in the greateſt diſorder towards A. It is hence clear that every effort ſhould be made by an army in line of battle, to turn the enemy's flanks with its front.

Concentric lines of marching and firing well executed, are exceedingly important. Hence it is that a fortreſs muſt yield when it is beſieged, as the fire from the fortreſs is *eccentric*, while that of the beſiegers is *concentric*. Hence, too, ſorties from a garriſon rarely ſucceed, becauſe they are eccentric operations.

When an army is much weaker than its opponent, if the former be compelled to an action, it ſhould throw itſelf on the enemies flanks; and to do this with effect, the enemy's front ſhould be kept occupied, ſo as to draw off his attention from his flanks. If the line were long, he would have time to convey all that part oppoſite to the ſide attacked, as A (fig. 15.) into the line *e f*, before the attacking army *e d* could entirely overthrow and repulſe the flank B, which would be the object of their efforts. In this caſe, things would again be equal; for an engagement in front would take place, the iſſue of which is always doubtful. If, however, they occupy the line AB, by corps ſent for that purpoſe, as *g* and *h*, while, with a greater force, they attack in flank, then it would be impoſſible for any part of AB to throw themſelves into the line *e f*, before having beaten *g h*; and the time would probably be too ſhort for this operation, if *c d* puſhed in front in a vigorous manner. From this it follows that the army AB, though the ſtronger, can do nothing better at this time than quit the field of battle, as it will otherwiſe be ſurrounded. Now, the attacking army have nothing to do but to effect an eccentric retreat; namely, to fall back with the left wing upon *i k*, and with the right upon *l m*, provided CD do not obſtruct the paſſage; for in that caſe, the retreat of the right wing, or of that part of the army neareſt the flank B, would be on *n*, in order to create in the enemy *c a* ſome ſolicitude for his left flank *d*. It is by ſuch eccentric retreats that the purſuit of the enemy is prevented. They dare not venture it, if they do not wiſh to be taken in flank themſelves, and to become in their turn expoſed to an eſcalade and a concentric fire, and conſequently a terrible havoc. Eccentric retreats in tactics are equally as advantageous as in ſtrategy. The latter kind alarm the enemy with regard to his lines of operation, and conſequently prevent him from advancing; the former make him afraid of expoſing his flanks and rear, and hinder him from purſuing.

Fig. 15.

From theſe conſiderations it appears that it is no great misfortune for an army to be attacked in its centre, and divided. If the army be divided in two at the centre, it will retire eccentrically on *e* and *f* (fig. 16.). By this movement it will throw an obſtacle in the way of all farther progreſs on the part of the enemy, who has divided in the middle the dotted line AB. It is impoſſible for the enemy *c d* to advance in front between *e* and *f*; they would take him in flank on both ſides: he muſt therefore advance in front towards *e* and *f*, both at the ſame time. In this poſition *e* and *f* might detach forces to the rear of *c d*, and operate at once on its proviſions and in its country. It would be ſufficient for that to ſend ſome corps from their flanks to the points A, B. It is likewiſe poſſible for them to advance entirely to the left and right, if they have any magazines at *g* and *h*, which nevertheleſs would not be expoſed by the marching of the flanks towards A and B, and would always be ſheltered from the enterpriſes of *c d*. A third combination likewiſe would be to attack immediately *c d*, which, from its poſition, would be expoſed on both its flanks. In this laſt caſe, *c d* would have no other reſource than to operate on that part of the flanks *e* and *f*, which are oppoſite to the points A, B, to compel *e f* to retreat, and replace its front in the direction of A, B.

Fig. 16.

It does not require a great body of men to occupy the front of the enemy, while the reſt of the army attacks the flanks. It is beſt done by means of a ſcattered troop, or what the French call *tirailleurs*, conſiſting of light infantry, which are uſually inſtructed in the following manner. The troop, formed into two ranks, divides in ſuch a manner that there may be a ſpace between the two, as indicated in fig. 17. The ſecond rank, placed behind the intervals left by the firſt, ſecures its flanks. When they attack, the ſecond rank, CD, paſſing through the intervals of the firſt AB, advances to the line EF, and fires. The great advantage ariſing from this, is that of forming a more extenſive front than when they are wedged in elbow to elbow; ſecondly, they keep up a more fatal fire with their muſketry, becauſe each ſoldier, being unmoleſted by the one next to him, aims better, and continues his firing without interruption; thirdly, a leſs number of men is loſt, becauſe

Fig. 17.

many of the enemy's balls fall in the intervals, and are conſequently harmleſs; but in the following method all theſe advantages are united in a more eminent degree. Here the diſperſed ſoldiers do not move in right lines, Fig. 18. but circularly, as repreſented in fig. 18. When the firſt rank has fired, the men make a little turn to the left, and run to the place occupied by the ſecond rank, the men of which advance rapidly in front to the place which the former had quitted, and fire, while the other rank is charging. Thus, each rank alternately advancing and retiring in circles, a conſtant fire is kept up on the enemy, with little hazard to the men. It muſt be allowed, however, that this method will ſucceed only when the enemy ſtand firm; for if they fly, the former method is to be preferred.

If the attacking army be forced to retire, the *tirailleurs* Fig. 19. that ſucceed them ſhould ſtop at N° 2. fig. 19. inſtead of proceeding as far as N° 1.; while thoſe that are already at N° 1. in retiring fall back farther than N° 2. thus each rank ſucceſſively falling farther and farther back, conteſting every inch of ground.

It may perhaps be maintained, that it is better in attack to adopt cloſe order, becauſe the lines of firing being more approximate, they can keep a better fire; but it may be replied, that if they are once on the flanks of the enemy, and ſufficiently near to uſe the muſket, it is then of little importance whether they attack with cloſe ranks, or *en tirailleurs*, becauſe in either caſe the enemy muſt be beaten if they charge with vigour. In ſuch a poſition, it would be difficult to throw one's ſelf in the Fig. 20. line *ef* (fig. 20.) particularly if it be occupied in front, as it ought to be, and it is neceſſary, that the cavalry ſhould be near, in order to ſuſtain this attack.

The retreats of the infantry intended to occupy the Fig. 21. front AB (fig. 21.), need not be either eccentric or in flank, the principal object being to direct the attention of the army AB from his flanks, which it is intended to attack; but theſe retrograde movements muſt be conducted directly upon *l f*. If the retreat be ſerious, and it be really intended to abandon the front AB, and to prevent the purſuit by creating in the enemy a ſolicitude for his flanks, then the retreat ſhould be executed eccentrically up *g h*.

Suppoſe an army collected in an oblique poſition, as Fig. 22. at CD, fig. 22. and ſuppoſe it is to make an attack on another army AB, coming round upon its flank. This manœuvre has been recommended by Folard, and was practiſed long ago by Epaminondas, and in modern times by Frederick the Great. It is however generally conſidered as inferior to the mode of attack illuſtrated in fig. 15. and AB might eaſily avoid the danger by moving along in line towards *f*, or taking the poſition A*g*. Indeed AB is itſelf, by its right wing A, in ſome degree enabled to act on the offenſive againſt the left wing of CD, by moving round in the columns *h i*. The conſequence of this mutual manœuvring would be, that CD takes AB on its flank B, while it is itſelf taken by AB on its own flank C; the two parts attacked will be probably beaten by the attacking army, and after the combat they will both remain oppoſite to each other, though a little obliquely with reſpect to their former front.

It is not always neceſſary to re-form the ranks. Sup-Fig. 23. poſe AB (fig. 23.) is attacked by the line CD, the left wing might run diſperſed towards *e f*, and there make a little turn to the right at a certain ſignal, return quickly, attack the left flank D, and give it a rolling fire from three ſides, before D, in order to defend himſelf, could take the form of an axe (*d'une hatche*) D*g*. But, in order for ſuch an attack to ſucceed, the enemy's cavalry muſt not be near. In caſe there be any to be apprehended, the precaution to be adopted would be to form into columns. If, therefore, attacks and retreats take place in this manner, and, above all, if care has not been taken to ſuſtain and cover them with a numerous cavalry, the greater part of the tactical evolutions of the infantry are rendered uſeleſs. It is, however, indiſpenſably neceſſary that the troops ſhould always know how to deploy from a column into a line of battle.

Captain Röſch, a Pruſſian officer, has diſcovered a method of deploying, which appears to be by far the eaſieſt and the beſt yet known. During the march, the diviſions proceeding on the line AB (fig. 24.) obſerve Fig. 24. the neceſſary diſtances. As ſoon as the diviſion 1 enters into the line of direction AB, it is commanded to the right or left, according to the ſide which they wiſh to face; the following diviſion arrives, without changing its ſtep, to the very place where the preceding one has made its *quart de converſion*, and performs a ſimilar one; the third, the fourth, and all the reſt follow the example. Each diviſion having thus traverſed its diſtance, reaches the line of direction, when that which marches directly in front has already made room.

This method is a ſtep further towards the perfection of deploying, which is to advance in front, for the diviſion 1 is obliged to make a *quart de converſion* to the left, before preſenting in front to the line, whilſt, according to the method of Captain Röſch, this line is formed merely by a *half-front*. At the ſame time, a converſion is a movement which always requires many paces, becauſe it is performed in the ſegment of a circle.

In the two methods of deploying repreſented at fig. 24. and 25. the diviſions traverſe the two ſmalleſt ſides Fig. 25. of a right-angled triangle (ſee fig. 25.) The Pruſſians have introduced a method, in which only the hypotheneuſe is deſcribed: it is called the *adjutant's ſtep*. The adjutants, who know from experience the length of the front of their battalions, meaſure with the gallop of their horſes on the line of direction, the ſpace neceſſary for appearing in battle (fig. 26.). Each battalion ſe-Fig. 26. parates from the column, and marches by the neareſt road to where their adjutants ſtand, at the numbers 1, 2, 3, 4, as intermediate points on the line of direction AB. As ſoon as the firſt diviſion arrives at the adjutant, it immediately deploys according to the method already deſcribed. If the officers who meaſure the front do not make any great miſtake, the march in front muſt be executed much more quickly than by the preceding method.

Let us now examine the beſt method of throwing back a wing into a line, ſo that it may not be turned. Suppoſe an oblique line at *c d* (fig. 27.) with a crotchet Fig. 27. *d e* formed to prevent being taken by the flank *d*; and at the ſame time, to have a line ready to repulſe every attack which the enemy AB, might attempt on the left againſt this flank. Such is the firſt modification which this kind of poſition offers to our examination. After this line, *en crochet*, has diſperſed every thing which oppoſed

poſed its progreſs, it turns, till it arrive at the prolongation of the oblique front CD, and then takes the enemy in flank.

At the battle of Liſſa *, ſome battalions of grenadiers were placed at the extremity of the right wing of the cavalry; they overthrew the troops of Wirtemburg, and performed other eſſential ſervices. But ſuch a poſition has this defect, that it offers a flank to the enemy, which can be enfiladed by his cannon. This would Fig. 28. happen to *c d* (fig. 28.), as well as *d e*, if the line AB extended beyond, and turned the oblique front *c d*. It would be poſſible, by means of a ſquare battalion, as *d, e, f, g,* to cover the flank which is attacking in the oblique order, but two ſides of this ſquare would be enfiladed by the cannon of the enemy. The defence of a parallelogram is therefore much weaker than that of a perfect ſquare.

Fig. 29. Fig. 29. repreſents what the Pruſſians call a *cremaillière*, a form extremely complicated, and liable to be enfiladed by the enemy. Another and ſtill more com-Fig. 30. plicated form of this order of battle is ſeen at fig. 30.

Fig. 31. Figs. 31. and 32. repreſent the order of battle in a ſquare, a form which is well adapted both to ſtrength and convenience. When it is intended to reinforce the ſquare battalion againſt cavalry, the third rank ſeparates from the two others, and forms by itſelf a leſſer ſquare, within that formed by the front and centre ranks. When this is done, if the enemy's cavalry ſhould penetrate into one of the angles of the firſt ſquare, the inner ſquare forms a ſalient angle by converſions to the right Fig. 32. and left, as repreſented by the dotted lines fig. 32. ſo as by a croſs fire to drive the enemy back again.

Many have propoſed to conduct retreats in various ſquare battalions; but it is neceſſary that they ſhould be ſmall ſquares, compoſed at the utmoſt of two or three battalions; and it is requiſite, that during the march, whether by angles or ſquares, they ſhould obſerve between each other ſuch a poſition, that the fire of the one flank ſhould reach to the ſides of the other in order Fig. 33. to protect it. (fig. 33. N° 1, 2, 3.). This laſt battalion 3 reaches the front 1, which laſt performs the ſame ſervice to the rear of 3, and to the front of 2; 2, on its ſide, protects the rear both of 1 and 3. It would be difficult in the field, for theſe different ſquares to preſerve ſuch a compreſſed poſition, and they would be in danger of wounding or killing each other by their croſs firing. Men well experienced in war have, however, preferred retreats of infantry in ſquare battalions, having the cannon in the centre or on the flanks, as repreſented in fig. Fig. 34. 34. In executing this movement, however, the diſtances are ſcarcely ever preſerved, eſpecially when it is neceſſary for a wing to deploy by a converſion during a Fig. 35. retreat, ſee fig. 35. in order to prevent the purſuit of the enemy. In every other reſpect theſe retreats being eccentric, are founded on good principles. See N° 33.

When, after a diſcharge of muſketry, an army has to retire, this movement cannot be expected to be executed in order. In this caſe a flight always takes place, for otherwiſe there would be no reaſon for quitting the field of battle. In this ſituation it is neceſſary to have a line of cavalry behind the infantry, to ſuſtain them; and then it is not ſo bad as is generally imagined, to fly haſtily into the midſt of the cavalry. It is only neceſſary that this ſcattered infantry ſhould re-form immediately, in the moſt convenient place, in a wood, or on an elevation; and if they return quickly to the charge, they will diſplay more courage, than in falling back, ſtep by ſtep, and loſing a number of men; for in the firſt inſtance it is a real and uſeful intrepidity, but in the ſecond it is nothing. If there be no cavalry to ſuſtain them in an open place, they muſt then remain united, or otherwiſe be cut in pieces.

When it is poſſible to effect a regular retreat, the beſt and eaſieſt method is to make a half-turn to the right with the whole line, and to march thus, progreſſively falling back; by this means they will ſooner eſcape from the fire of the enemy than in any other manner, and the order is much more eaſily kept, which is of importance, and deſerves to be properly appreciated. There is not a more pitiable object than a ſquare battalion ſurrounded by *tirailleurs*, (fig. 36.). All their Fig. 36. ſhot are concentric, and conſequently eminently effective, while thoſe of the ſquares are eccentric, which renders them almoſt nugatory. The ranks of this unhappy ſquare would ſoon be thinned by a well-directed fire, which could not miſs its aim; and a battalion, in this poſition, would find it impoſſible to eſcape deſtruction.

The moſt celebrated modification of the oblique front, is that made by Frederick the Great, viz. the oblique attack in rounds. Experience has not yet proved what there is peculiarly excellent in this manner of attacking; and Captain Röſch has ſhewn that it is not tenable in theory. He demonſtrates that each *échellon* would be received by the enemy with a ſuperior fire; for the one *c d* (fig. 37.) if it approach the Fig. 37. line AB, within muſket ſhot, would be caught in its flank *c*; which being turned, and expoſed to a ſide fire, would inſenſibly deſcribe an arch in its rear, to have its adverſary in front. The diviſion of the line AB, which in this caſe would pour upon the flank *c* of the *échellon*, *c d*, ſuch a fatal fire, would be in no way hindered by the ſecond *e f*, which is too far off to fire; and, beſides, the firſt two diviſions of the wing *f* dare not fire, at leaſt not with ſafety, if the *échellon* were 300 paces diſtant, for fear of reaching them in the flank *c*. Thus, the two diviſions of the line AB, which are oppoſite to the *échellon*, *c d*, would continue their fire upon the fatal rank *c*, without the leaſt interruption. If they be not more than 50 or 100 paces diſtant, theſe inconveniences will not take place; but at the ſame time, the advantages which were expected to reſult from an attack *en échellon* will be loſt. Theſe advantages are, that, by dividing the front, only one part is liable to be beaten, as the others would be neglected; while on the contrary, in an oblique line, without any interruption, the diſorder rapidly ſpreads through its whole extent. It would be poſſible, in order to derive every advantage from this manœuvre, to augment conſiderably the fire of the firſt *échellon*, as well as the one immediately ſubſequent, by doubling their lines, and leaving the others weaker. Hence it is evident, that this mode of attack is eligible only when we are a-head of an enemy ſtronger than ourſelves; for if we have a ſuperior force, it is certain that the moſt energetic method would be to attack at once the adverſary in front and both flanks.

There is ſcarcely an inſtance previous to the battle of Marengo, in which a ſecond line of infantry has renewed the combat, by taking the place of the firſt which has been beaten. If the combat be continued with bayonets,

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* See *Pruſſia*, N° 35.

bayonets, it would be ſufficient for a diviſion of the line AB to make a converſion on the flank of the *échellon* *c d*, while they are fighting in front, and overthrow it before *e f*, 300 paces diſtant, or even the ſecond line of the *échellon*, could come up to afford it any aſſiſtance. Thus, according to all appearances, the line AB would conquer all the *échellons* ſucceſſively, and this the more eaſily as they would be taken in flank as ſoon as *c d* is obliged to fly.

The moſt uſeful, and in fact the only proceſs for reinforcing an attack, is to have a ſecond line of cavalry behind a firſt of infantry; in caſe of bad ſucceſs they ſecure and cover their retreat, and complete the diſorder of the enemy's infantry, if they come to an engagement.

When the infantry is ranged *en echiquier*, a firſt line when beaten, may retreat by files through the lines in the rear, without creating any diſorder in the ſecond, on account of the extenſive ſpaces; but it is not the ſame with the long phalanx in open order. The cavalry, placed immediately behind the infantry, protects an attack much better than if there were between them a ſecond line of infantry; for in the firſt inſtance, there would be no hindrance to their haſtening to the ſuccour of the runaways, and receiving them in their boſom. Hence there ſhould be only two lines, one of infantry, and one of cavalry; and this is the more important, becauſe the two lines of infantry cannot be uſeful, except in as far as they are beyond the ſhot of the cannon; it is evident, therefore, that they ſhould be conſidered rather as a reſerve of freſh troops than as a ſecond line of combatants. Hence, the ſupperadded ſtrength which is ſuppoſed to be given to the *échellons*, by double lines of infantry, is quite illuſory.

Cannons which fire concentrically, aſſiſt greatly the efficacy of an attack; but this meaſure may be employed as well for right lines as for the *échellons;* in an attack of the latter kind, the batteries ſhould not be placed before the diviſion *c d*, but before *e f*, to enfilade that part of the line AB, which would attempt to fall back to make a converſion, in caſe it were attacked in flank by *c d*.

It is impoſſible to take the enemy in flank by the diagonal or ſide-ſtep, executed during the march, if, previous to commencing their march, they are not already conſiderably by their wings; for they would completely fruſtrate that ſcheme, if they made directly with their flanks a movement to the ſide. During the ſame time they would paſs over a more conſiderable extent of ground than with an oblique ſtep, becauſe they move in a direct line, and in front, and obliquely, both at the ſame time, which would conſiderably ſhorten their diſtance; and likewiſe becauſe they march on one of the ſides and you on the hypothenuſe, which is longer. It is therefore impoſſible to ſucceed in ſtretching beyond the wings of the enemy, while they are advancing in front in the order of battle, if they know how to conduct themſelves.

There is, however, one advantage to be noticed, which the *échellons* poſſeſs over the uninterrupted oblique front, which is, not expoſing the flank to the enemy advancing in front. The *échellons* naturally poſſeſs this advantage, while the oblique front cannot obtain it without being much more extenſive than the enemy's front; for the oblique line, formed into *échellons*, changes into a number of parallel lines by a converſion (fig. 38.), and they may, by this movement, defend their flanks againſt the enemy. But ſtill the beſt way is to attack him in his own flanks, whilſt his front is amuſed with detached corps, and the columns ſhould be prepared for the principal attack out of ſight of the enemy, in the ſame manner as an admiral adopts at a conſiderable diſtance, his meaſures for gaining the windward of the enemy. No manœuvres within cannon-ſhot, can poſſibly be attended with ſucceſs, if the enemy be ſkilful.

Fig. 38.

41 Liſt of remarkable battles.

Much uſeful military inſtruction may be derived from peruſing the accounts of the moſt celebrated battles, detailed by writers of ancient and modern hiſtory; and we could here enumerate a long liſt of theſe engagements, many of which have been deſcribed in the hiſtorical articles of this work. A few, however, muſt ſuffice. Of ancient battles we may notice thoſe of MARATHON* in 490 B. C.; Platæa, 479; LEUCTRA*, 371; the GRANICUS*, 334; ARBELA*, 331; the Thraſymene Lake †, 217; CANNÆ*, 216; ZAMA*, 202; Magneſia ‡, 190; Nepheris, 147; PHARSALIA*, 48; and PHILIPPI*, 42. Of modern battles, the moſt important are thoſe of HASTINGS*, A. D. 1066; the Indus ‖, 1221; Bannockburn §, 1314; CRESSY*, 1346; POICTIERS*, 1356; AGINCOURT*, 1415; Boſworth**, 1485; Flodden §, 1513; Pavia, 1525; Narva ††, 1700; BLENHEIM*, 1704; RAMILLIES*, 1706; Pultava ††, 1709; MALPLAQUET*, 1709; Fontenoy ‡‡, 1745; Prague and Colin ‖‖, 1757; Liſſa or Leuthen ‖‖, 1757; Minden, 1759; Freyburg, 1762; Jemappe, 1792; Tirlemont, 1793; Fleurus, 1794; Lodi, 1796; Zurich, 1799; Ulm, 1800; Marengo, 1800; Auſterlitz, 1805; and Wagram, in 1809.

By way of illuſtrating the modern French tactics, and more fully explaining what has been ſaid on the order of battle, we ſhall here give a detail of the battle of Jemappes, in which Dumourier entirely defeated General Clairfayt, by enticing him from a ſituation where he was impregnable.

42 Battle of Jemappes. Plate DLIV.

In the beginning of November 1792, when Dumourier arrived with his army in the vicinity of Mons, he found the Auſtrian general Clairfayt occupying a ſtrong poſition on the heights near the village of Jemappes, where he had entrenched himſelf, and was defended by nearly 100 pieces of cannon. The poſition of the Auſtrians was extremely formidable. Their right extended to the village of Jemappes, and formed a ſquare with their front and left, which ſtretched to the cauſeway of Valenciennes. They were poſted on a woody mountain, where they had erected, in an amphitheatre, three tiers of redoubts. Their whole force amounted to about 16,000 infantry, and 3000 cavalry.

The army of Dumourier was much more numerous than that of Clairfayt, but not ſo well ſupplied with artillery. The elevation of the Auſtrian batteries, too, gave them ſuch an advantage, that the French cannon could produce but little effect.

On the 5th of November, Dumourier had fully reconnoitred the Auſtrian camp, and, by way of feint, made an attack with his infantry on the village of Carrignon, while he kept up a briſk cannonade on their left. Towards evening the French army encamped oppoſite to Jemappes, with its left wing extending to Hoorne, and its right to Fremery. As Dumourier reſolved

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* See *theſe articles.*

† See *Carthage*, N° 113.

‡ See *Syria.*

‖ See *Gazna.*

§ See *Scotland*, N° 192. and 405.

** See *England*, N° 237.

†† See *Ruſſia*, N° 107. and 118.

‡‡ See *Britain*, N° 414.

‖‖ See *Pruſſia*, N° 26, 35.

ſolved to make a deciſive attack on the heights of Jemappes the next morning, he ordered his troops to abandon the village of Carrignon, which was commanded by the enemy's cannon.

On the morning of the 6th, he ordered his artillery to be advanced and diſpoſed along the front of the line. It was ſoon found, however, that little was to be done with artillery, and that the great object was, to entice the Auſtrian general from his ſtrong poſition, and draw him to the plain. For this purpoſe, at noon of the 6th, the French infantry formed in columns, and advanced with the greateſt ſpirit and rapidity to the Auſtrian intrenchments. The lower tier of redoubts was inſtantly carried; but, as the centre of the French became endangered, and the Auſtrian cavalry appeared deſcending from the heights, and preparing to enter the plain, with an evident intention of flanking the French columns, Dumourier deſpatched the duke of Orleans to lead thoſe columns againſt the ſecond tier of redoubts, while a detachment of chaſſeurs and huſſars flew to check the progreſs of the Auſtrian cavalry. Some ſmart ſkirmiſhing between the cavalry on both ſides now enſued, and while this diverſion was taking place, the left diviſion of the French army poſſeſſed themſelves of the village of Jemappes, while its centre obtained entire poſſeſſion of the ſecond tier of redoubts. In the mean time the whole of the Auſtrian cavalry had quitted the heights, and engaged the French on the plain below Jemappes. This was the point to which Dumourier had wiſhed to bring them, and now the ſuperior numbers and activity of the French quickly decided the fortune of the day. The Auſtrians were routed at every point, and forced to abandon the field of battle, leaving 5000 of their dead, with the greater part of their artillery. The loſs of the French, however, was conſiderably greater, and is, on good authority, eſtimated at 14,000; but this loſs appeared trifling to Dumourier, as by this victory he acquired poſſeſſion of the whole of the Auſtrian Netherlands.

The poſitions of the French and Auſtrian forces in this battle are repreſented in Plate DLIV. 1, The centre of the Auſtrian army, commanded by Clairfayt. 2, A part of this army commanded by General Lilien. 3, Another part under the command of General Beaulieu. 4, Redoubts on the heights of Jemappes. 5, Auſtrian intrenchments. 6, French columns advancing to attack the intrenchments. 7, A battery. 8, Columns of cavalry. 9, Columns attacking the eminences above Mons. 10, Battery on the height of Fremery. 11, The wood of Freſnee. 12, The plain on which the French and Auſtrian cavalry were engaged. 13, Auſtrian detachment.

The columns N° 9. were firſt engaged; and N° 6. having obtained ſome advantage, Dumourier ordered the battery, N° 7. to be erected, by which the redoubts, N° 4. were ſilenced. In the mean time the French advanced againſt the intrenchments, 5, and attacked in front. From the left of the French army, as far as the centre, the cavalry fought hand to hand, in the plain, 12, with the Auſtrian horſe, which was dreadfully cut up in the wood of Du Freſnee, 11. The right of the Auſtrians, being totally routed, gave way and fell back on Mons. The ſuperiority of the French in numbers is evident from inſpecting the columns in the plan.

43 Of ſieges.

After having dwelt ſo long on that part of military tactics which relates to operations in the field, we muſt be extremely brief with reſpect to the attack and defence of fortified towns. Indeed our principal object in this part will be to explain the nature of a ſiege, and the various circumſtances that may occur, both on the part of the beſiegers, and on that of the beſieged, rather than to lay down a ſyſtem of inſtructions for either party. With this view, we ſhall firſt enumerate the principal inſtruments and engines employed in the attack or defence of a fortreſs, and explain the nature and conſtruction of the works conſtructed by the beſiegers, either for the purpoſe of making their approaches to the place, or for undermining its walls or outworks.

44 Inſtruments employed in ſieges. Plate DLV. Fig. 1—20.

In Plate DLV. are repreſented the principal inſtruments employed in ſieges. Fig. 1. is a faſcine for the conſtruction of redoubts or temporary defence of a detachment. Figs. 2. 3. and 4. exhibit various views of what are called *gabions*, or cylindrical caſes of wicker work, open at both ends, for ſticking into the ground, as ſeen at fig. 4. when they are filled with earth, and faſcines, &c. laid on them. Fig. 2. is a ſection of the gabion; fig. 3. ſhews its hollow inſide, and fig. 4. is its elevation. Fig. 5. and 6. repreſent bags for holding ſand, the former empty, the latter full; and fig. 7. repreſents the manner in which they are uſually diſpoſed for the protection of the men. Fig. 8. is a ſauciſſon, or very long cloſe faggot, for laying over gabions. Fig. 9. is the outline of a blind, which is ſtuck into the earth by the ſharp ſtakes at its extremity, and hides the workmen from the beſieged. Fig. 10. repreſents what is called a chandelier, and fig. 11. two of theſe with faſcines piled up acroſs them. Fig. 12. is a cheval de frize; fig. 13. 14. 15. exhibit various views of a *mantlet*, or moveable blind placed on two wheels, uſed both to protect and conceal the workmen of the beſiegers. Fig. 13. is a plan of the mantlet; fig. 14. a ſide view of it, and fig. 15. a view of its front next the enemy. Fig. 16. is a madrier or ſcreen with two leaves, moveable on wheels; and fig. 17. repreſents a gate with orgues or lattice work on one ſide, and a portcullis on the other. Fig. 18. is a hook, and fig. 19. a fork uſed in ſapping. Fig. 20. repreſents three caltrops or crows feet, uſed to ſcatter over the ground, to prevent the approach of cavalry, by laming their horſes feet. For a fuller explanation of theſe inſtruments, ſee the ſeveral articles in the general alphabet.

45 Of inveſting.

When a town is about to be beſieged, it is firſt *inveſted;* that is, a conſiderable body of troops, uſually cavalry, encamp in its neighbourhood, and take poſſeſſion of all the avenues till the army arrive, which is to carry on the regular operations of the ſiege.

46 Of lines of circumvallation.

When the army has *ſat down* before the place, its firſt object is, to aſcertain the lines or direction of the works to be thrown up for the attack of the place. Theſe are called *lines of circumvallation*, and their direction is to be determined by the plan of the fortification about to be beſieged. After aſcertaining, in the manner explained under Fortification, the number of ſides of which the polygon of the place conſiſts, and the length of each, as well as the radius of a circle to be drawn round the place, concentric with its works, the polygon of the circumvallation is eaſily deſcribed. This being traced, the engineer takes on each of the extremities of its ſides the lines BD and BE, fig. 21. each of 15 fathoms, and from the points D and E, taken

Fig. 21.

taken for the centre and diſtance of 25 fathoms, he deſcribes two arcs cutting each other at F, whence are drawn the lines FD, FE, for the faces of the redans of the line of circumvallation; thus are formed the ſalient parts EFD of this line, which ſerve to flank it. The ſame operation is performed on every ſide of the circumvallation, and then the principal line is traced. The parapet within muſt be ſix or eight feet deep, and without is made a ditch parallel to all its parts, three or four fathoms in breadth. The parapet of the circumvallation will be 7½ feet high, and the depth of the ditch equal to the height of the parapet.

Fig. 22.

To make the profile of the circumvallation, let AB, fig. 22. be a line level with the country, and CD the ſcale of the profile. Let A be the ſide of the town, and B that of the country; take AE of ſix feet; from the point E, raiſe the perpendicular EF, of three feet, and draw the line AF, which will be the talus or ſlope of the banquette.

Draw FG parallel to AB, three feet from F to G, and the line FG will be the breadth of the banquette. On the point G raiſe the perpendicular GH, on the line FG, 4½ feet. Draw from the point H, HK parallel to AB; make HK 7½ feet, HI, 1½ foot; draw GI, which will be the inſide of the parapet of circumvallation.

From the point K, let fall on the line AB the perpendicular KM; take KL 1½ foot, and draw IL, which will be the upper part of the parapet of the line of circumvallation. Take MN equal to five feet, and from the point N draw the perpendicular NO, and ſet off 7½ feet from N to O. Draw OR parallel to AB, making the diſtance equal to 18 feet from O to R; draw LN, and produce it to P, and LP will be the ſcarp. From the point R raiſe RS, perpendicular to OR, or parallel to ON. Make QR=OP, and draw QS, which produce beyond S, three feet to V; then take SX equal to ſix feet, and draw VX, and the profile of the circumvallation is completed; VQ being the counterſcarp, and VX the glacis.

At A and A (fig. 21.) are ſmall half moons before the gates of the circumvallation in the middle of the curtains.

Plate DLVI. Fig. 1. 2. 3.

In Plate DLVI. at fig. 1. is repreſented the manner in which the lines of circumvallation were drawn at the ſiege of Philipſburg in 1734. In theſe lines regular baſtions were conſtructed, as ſeen in fig. 2.

Fig. 4. 5.

Fig. 4. and 5. of the ſame plate repreſent another line of circumvallation drawn round the city of Arras, when it was beſieged by the Spaniards in 1654. Before the circumvallation were dug a great number of holes, two feet in diameter, and 1½ foot deep, in which were faſtened ſtakes for obſtructing the approach of cavalry.

47
Of the trenches and parallels.

Plate DLVII. Fig. 2.

While the lines of circumvallation, which are intended to protect the beſiegers from the enemy without, are conſtructed, all materials neceſſary for the trenches are got ready, and the figure and direction of theſe are determined. If the place be regularly fortified, and ſtand on level ground, it is indifferent on which ſide the beſiegers commence their attack. Suppoſe C, fig. 2. Plate DLVII. to be the place beſieged, and A and B two baſtions to be attacked. The beſiegers begin with indefinitely producing towards the field the capitals of theſe two baſtions; in like manner the capital of the half moon oppoſite the curtain between theſe two baſtions is produced. Eight hundred fathoms are ſet off from the ſalient angles D and E of the covert-way of F and G. This done, the lines DH and DI are drawn, each equal to 300 fathoms, and about the centre C with the radius CH or CI, is deſcribed an arch produced beyond H and I, and on this arch HI is conſtructed the firſt parallel. Then on the ſame lines DF, EG, are taken the points M and N, each 140 fathoms diſtant from H and I; and through theſe points M and N, about the centre C, is deſcribed another arch, on which is conſtructed the ſecond parallel. This ſecond arch will cut the produced capital of the half-moon in the point L, which is to be obſerved, in order to begin from hence a trench which may extend to the ſalient angle of the covert-way before this half-moon. Laſtly, through the points O and P, the diſtance of 20 or 25 fathoms from the angles D and E, a third arch is deſcribed from the centre C, on which the third parallel is conſtructed. The firſt parallel is terminated by producing the faces *a b*, *a b*, of the half-moons 1 and 2, collateral to the baſtions A and B; but the parallel is extended 15 or 20 fathoms beyond the interſection of this prolongation. The ſecond parallel will be leſs extended than the firſt, by about 30 fathoms on each ſide, and the third leſs than the ſecond by the ſame diſtance.

The trenches or approaches are now to be traced. For this purpoſe, the engineer takes a long ruler, and lays it on the point G, ſo that it may make with the produced capital EG of the baſtion B, an angle EGS, whoſe ſide GS being produced, ſhall meet no part of the covert-way, and ſhall be diſtant about 10 or 12 fathoms from the angles to which it approaches neareſt. GS is taken of any extent, and the ruler is put on the point S; ſo that it ſhall make with GS ſuch an angle GST, as that the ſide ST produced ſhall not fall on any part of the covert-way, but be 10 or 12 fathoms diſtant from the moſt ſalient parts. This ſide is terminated in T; and now the angle STI is made, whoſe ſide TI ſhould terminate at the point I, where it meets the firſt parallel. The ſame operation being performed on FH, the outline of the trenches is completed as far as the firſt parallel.

Fig. 1. of this plate illuſtrates the method of conſtructing what are called *lines of countervallation*. Theſe are drawn nearer the town than the lines of circumvallation, but are conſtructed on the ſame principles. They are employed chiefly when the garriſon of the place is ſo ſtrong as to diſturb the operations of the beſieging army by ſallies.

Plate DLVIII. Fig. 1.

In ſieges where the garriſon is ſtrong, it is often neceſſary to cut parts of trenches, as VV (fig. 2). between the ſecond and third parallels, ſo as to communicate with the main trench. Theſe parts of parallels are denominated *half parallels*, or places of arms, and are conſtructed in the following manner. Let ABCDFGMQ (fig. 1. Plate DLVIII.) be a part of the trenches, and let AB be one of the ſides oppoſite to the enemy; produce AB, ſo that BE ſhall be five or ſix fathoms, and in FG take alſo five or ſix fathoms from I to L, which will give the ends of the trench BFLI, the uſe of which is to cover the *boyace* or branch IOMG, whereby the enemy will not know the place where it falls into the trench AB, and to make room for withdrawing thoſe who are in this part of the trenches, es, and that the paſſage may be free at all the angles. In like manner produce the ſide GM from M to N, and the ſide IC from O to P, and this will give the end of the trench MNOP, which will cover the branch DCOQ. The ſame is to be done at all the angles of the trench. The parapet of the trench being made to cover it, ought to change ſides alternately. If, for inſtance, AE, in the preceding figure, be towards the place, it is evident that the ſide GN will be towards it alſo, and likewiſe the ſide CD; and therefore the parapet of the trench is ſucceſſively conſtructed from the right ſide to the left, and from the left to the right.

Figs. 2. 3. 4. of this plate repreſent profiles of the regular trenches and the places of arms, and require no particular explanation.

Fig. 5.

In tracing the trenches, it is of the greateſt conſequence to aſcertain the diſtance of the extremity of the line of direction to the top of the ſalient angle of the covert-way. The following ſimple method of doing this is given by Vauban. Let A (fig. 5.) be the vertex of the ſalient angle of the covert-way, and AB the line of direction of the trench whoſe length is required. At the point B, draw BC perpendicular to AB, to which give any meaſure, and at the point C draw CD perpendicular to BC. In CD take any point E, and in the line of direction between it and the angle A place a picquet G in the line BC. Meaſure GC and CE, and ſay, as GC : BG :: CE : AB.

48
Of ſaps.

Plate DLVIII. Fig. 6. 7. 8. Plate DLIX. Fig. 1. 2.

When in carrying on the trenches towards the town, the workmen begin to be much annoyed by the fire of the beſieged, recourſe is had to what is called *ſapping*, which may be thus explained. Let ABC be the part of the trenches advanced to A (fig. 6. Plate DLVIII.), ſo near the town as to render it impoſſible, without evident danger, to work any longer at the approaches, unleſs the men have ſome cover againſt the fire of the place; and let the branch AD be traced by the engineer, not with a cord, as at the opening of the trenches, but with ſome pickets, which he has taken care to place in the direction this branch ought to have, to ſerve as a guide to the workmen. A cut is made in the parapet BA of the trenches, and then the men deſigned to work by ſap, who are therefore called ſappers, will move forward through the opening A ſucceſſively, eight in number. Fig. 7. of Plate DLVIII. and fig. 1. of Plate DLIX. will illuſtrate the mode of operation. The firſt ſapper rolls a mantlet before him, and places a gabion on the line AD, fig. 6. He then makes a ſmall excavation about ſix inches from the gabion, of about one foot and a half in depth, and as much in breadth, emptying the earth which he digs up into the gabion. He then puſhes forward his mantlet, fixes another gabion, and continues his trench as long as he is able. He is followed by a ſecond, who widens the trench ſix inches in breadth away from the gabion, and ſix in depth. The reſt follow this ſecond, till the trench is made three feet wide, and as many deep, and as ſoon as the gabions are filled with earth, faſcines or ſauciſſons are placed on their top, and the ſuperfluous earth is thrown over them, and on the oppoſite ſide, by way of parapet.

49
Of batteries.

Plate DLIX. Fig. 3.

Cannon are made uſe of at a ſiege for two different purpoſes; the firſt to drive away the enemy from their defences, and the ſecond to diſmount their guns. To produce theſe two effects, the batteries ſhould not be above the mean reach of cannon-ſhot from the place; that is, above 300 fathoms. Therefore there is no poſſibility of conſtructing them till the firſt parallel be formed; and as the diſtance of this firſt parallel from the place is generally 300 fathoms, the batteries muſt be on this line, or beyond it, nearer the town. They muſt always be placed, when the ground will permit, on the produced faces of the works attacked. Let Z be the centre of the place attacked (fig. 3. Plate DLIX.), and the trenches as well as the parallels completed. To find a proper poſition for erecting batteries, produce the faces AD, AC, BE, BF, of the two baſtions attacked, till their prolongation cuts the firſt parallel. Produce alſo the two faces OM and OL of the half-moon MOL of the front attacked, and the faces HG and IK of the two collateral half-moons 1 and 2, to the firſt parallel, and erect batteries on thoſe produced faces, as is ſeen in P, Q, R, S, T, U, X, and Y. They are advanced beyond the firſt parallel 40 or 50 fathoms; and are parted from the trenches, that they may be uſed with greater eaſe and convenience, and leſs trouble to the workmen.

50
Of traverſes.

Plate DLX. Fig. 1.

When the works of the beſiegers approach the glacis, they are continued in a zig-zag direction, by ſhort angular trenches, but from the foot of the glacis they are continued in the following manner. Two ſets of ſappers, protected by their mantlets, make a ſap on each ſide of the ridge of the glacis, with a deeper ditch than uſual, and a parapet on each ſide. This is called a double ſap, and has acroſs it traverſes or banks three fathoms thick (ſee Plate DLX. fig. 1.), with ſmall paſſages on one ſide (ſee fig. 4.) to preſerve the communication. Theſe traverſes are conſtructed ſo near to each other, as to be a ſufficient cover, by their elevation and diſtance, againſt the fire of the place. In order to guard againſt the effect of grenades, on coming within their reach, or within 14 or 15 fathoms of the covert-way, care muſt be taken to cover this trench with blinds, or to cover the upper part of it. Fig. 1. and 2. of Plate DLX. ſhew this direct trench. The firſt exhibits the plan, and the ſecond the profile, which paſſes over one of the traverſes. This being done, and the third parallel finiſhed in the manner ſuppoſed, they advance from this parallel on the glacis to each of the ſalient angles of the covert-way of the front attacked, and begin with making two or three ſhort turnings, as marked on Plate DLX. fig. 6. along the ridge of the glacis, ſo as to occupy about one-third of it. Theſe are to be made as deep as is neceſſary, to be a ſhelter againſt the fire of the covert-way; afterwards they may proceed directly along the ridge of the glacis by a deep ditch, to the ſalient angle of the covert-way. M. Vauban obſerves, that if we follow directly the ridge of the glacis, this trench is made without much danger; for the paliſade which is placed at the ſalient angle of the covert-way, and the other two next it, do not preſent directly to the ridge, but only oppoſite to the faces, where at moſt there is only room for one or two fuſileers to ſee the head of the trenches, and who are eaſily ſilenced by the fire of the third parallel, which ought to be well ſerved, and likewiſe by that of the ricochet. On coming to the middle, or two-thirds of the glacis, two new ſaps are made, *b b*, *ibid.* which embrace both ſides of the covert-way, to which they are almoſt parallel. Their length is 18 or 20 fathoms, and about five broad.

Fig. 6.

broad. They are covered at the end with crochets and winding traverſes, which prevent the fire of the covert-way from enfilading them eaſily.

Fig. 5.

In this way is gradually effected a *lodgement* on the covert-way, as is repreſented in fig. 5. where AAAA, is the trench, with BBBB its traverſes.

Plate DLXI. Fig. 5.

Plate DLXI. fig. 5. repreſents a profile of theſe works, with three banquettes next the trench, by which the parapet is raiſed, ſo that the ſoldiers may fire over into the covert-way. This work is called by Vauban, the *cavallier of the trench*.

51
Of batteries on the covert-way.

When the beſieged are entirely driven out of the covert-way, the next thing to be done is the erecting of batteries, in order to ruin the defences of the place, and to make a breach. As it is neceſſary for the beſiegers to make themſelves maſters of the half-moon C, (Plate DLX. fig. 6.) before they can come to the body of the place, which is defended by part of the faces of the baſtions A and B oppoſite to its ditch, they muſt begin with erecting batteries on the covert-way oppoſite to theſe parts. They are marked on the plan *e e*. Batteries muſt alſo be erected to make a breach on the half-moon. But, before they are erected, it will be proper to conſider what part of the face of the half-moon is to be attacked, or what part of the half-moon is to be entered. It muſt not be at its flanked angle, becauſe an opening towards the point would not afford a ſufficient ſpace to make a lodgement able to withſtand the enemy, and the troops would be ſeen in their paſſage by the two faces of the baſtions by which its flanked angle is defended. The moſt favourable paſſage is towards the third part of its face, reckoning from its flanked angle, becauſe by battering at the ſame time the two faces near this part, the whole point of the half-moon may be deſtroyed, and a large opening made there eaſier than anywhere elſe. Thus the batteries for making a breach in the half-moon C will be placed in *d* and *b*, and will occupy almoſt one-third of each of the faces of the half-moon from its flanked angle. Theſe batteries are each to conſiſt of four or five pieces of cannon. When the faces of the baſtions A and B are well enfiladed by ricochet batteries, there will be no further occaſion for the batteries *e*, *e*, and when the half-moon is taken, the faces of the baſtions A and B may be deſtroyed, by uſing the batteries *d*, *d*, placing them in the ſituation of *e*, *e*. Batteries muſt alſo be erected to deſtroy the flanks of the demibaſtions in the front of the attack; and it is evident that they can be placed nowhere but at *i*, *i*, on the covert-way. Beſides theſe batteries, others are erected in the re-entering places of arms of the covert-way, as in *k*; and in *k* they ſerve to batter the tenaille when there is one, the curtain, and the faces of the baſtions. Sometimes they are of mortars for throwing ſtones.

Plate DLX. Fig. 6.

52
Deſcent and paſſage over the ditch of the half-moon.

While the workmen are employed in erecting batteries on the covert way, preparations are made for paſſing the ditch of the half moon. This is often a difficult and dangerous undertaking, as this ditch is commonly very deep, is well defended, and either filled with water, or in general capable of being ſo filled. The deſcent into the ditch is commonly effected by ſubterraneous paſſages or galleries, made like thoſe of miners, and erected in ſuch a manner, that its opening into the ditch may be oppoſite to the breach where it is intended to make the aſſault. Theſe galleries are ſloping, and in general there are ſeveral for the ſame paſſage. The paſſage is made on each ſide of the faces of the half moon. See *m m*, fig. 6. Plate DLXI.

Plate DLXI. Fig. 1—4.

As the buſineſs of forming theſe galleries is liable to be obſtructed by mines from the beſieged, the workmen are protected by a guard of grenadiers. At fig. 1. Plate DLXI. is ſeen a plan of the deſcent under ground, and of its opening into the dry ditch; and fig. 2. gives a profile of the ſame paſſage; fig. 3. gives a perſpective view of the opening of this deſcent, ſeen from the bottom of the glacis, and fig. 4. a ſimilar view of the opening of the ſame deſcent, ſeen from the top of the breach.

Plate DLXII. Fig. 1—4.

At Plate DLXII. fig. 1. is ſeen the plan of the paſſage over a wet ditch in the open air; that is to ſay, the gallery of which is an open ſap. A is the opening of it; at B, towards its opening, are ſeen the blinds laid on its upper part, to ſupport the faſcines with which it is covered. On theſe blinds, at firſt, is laid a bed of faſcines, ranged according to the length of the gallery: over this firſt bed a ſecond is laid, whereon the faſcines are ranged according to the breadth of the gallery, as is ſeen at B and C. D is the epaulement of faſcines, which covers the paſſage againſt the fire of the place by which it is flanked. E is part of the bridge of faſcines; and F is an elevation alſo of faſcines, intended to cover the head of the work, and to ſecure it from the immediate fire of the place. Fig. 2. repreſents the profile of this deſcent into the ditch. Fig. 3. gives its opening ſeen in perſpective from the country; and fig. 4. its opening into the ditch, alſo in perſpective, as it appears from the top of the breach.

Fig. 5.

The following references will explain fig. 5. of Plate DLXII. *a*, cavaliers of the trenches. *b*, batteries of ſtone mortars. *c*, batteries to breach the half moon before the hornwork. *d*, batteries againſt the defence of this half moon. *e*, paſſages over the ditch before this half moon. *f*, lodgements in it. *g*, batteries againſt the flanks of the hornwork. *h*, batteries to breach the half baſtions of the hornwork. *i*, batteries againſt its curtain. *l*, lodgements in the half baſtions, and in the hornwork. *m*, paſſages over the ditch before the retrenchments in the hornwork. *n*, lodgements in theſe retrenchments. *o*, batteries againſt the defences of the collateral half moons. *p*, batteries to breach thoſe half half moons. *q*, paſſages over the ditch before theſe works. *r*, lodgements in the ſame. *s*, batteries to breach the redoubts of the half moon. *t*, paſſages over the ditch before the redoubts. *u*, lodgements in the redoubts. *x*, bridge of faſcines. *y*, batteries againſt the defences of the baſtion A. *z*, batteries to breach this baſtion. B, paſſages over its ditch. C, lodgements in the baſtion A. D, lodgements on the border of the ditch before the retrenchment of the baſtion A. E, paſſages over the ditch before this retrenchment.

There are places which, without any fore-ditch, have lunettes oppoſite to the ſalient and re-entering angles of the glacis, which are alſo enveloped by a ſecond covert-way: ſometimes they are vaulted and bomb-proof, as at Luxemburg; and ſometimes they have only a ditch, a parapet, and covert-way. Thoſe which are vaulted and bomb-proof are not eaſily taken, becauſe the ricochet firing and the bombs can do them no miſchief. In that caſe they muſt either be turned, or be taken by mines. A work is ſaid to be turned, when the beſiegers

gers get between that work and the place, and ſo cut off their communication. Sometimes the lunettes have communication under ground, and then there is ſcarcely any other way of driving out the enemy but by mines. This is tedious, but there is no other remedy. The lunettes of the ditch are always defended by branches of the covert-way, with which they have alſo a communication like thoſe of the lunettes, A, A, Plate DLXIII. fig. 1. This plate, which repreſents part of Landau and its attacks in 1713, may ſerve to give an idea of the manner in which a work is turned. The advanced lunette B, as well as the work C, called a *tenaille*, is turned; that is, the trenches cut off the communication betwixt them and the place.

Plate DLXIII.

53 Principles to be obſerved in the attack of fortified places.

We ſhall conclude this ſubject of the attack of fortified places, with the following principles to be obſerved by the beſieging army.

The approaches ought to be made, without being ſeen from the town, either directly, obliquely, or in flank.

No more works ſhould be made than are neceſſary for approaching the place without being ſeen; that is, the beſiegers ought to carry on their approaches the ſhorteſt way poſſible, conſiſtently with being covered againſt the enemy's fire.

All the parts of the trenches ſhould mutually ſupport each other, and thoſe which are furtheſt advanced ought not to be diſtant from thoſe which are to defend them above 120 or 130 fathoms.

The parallels or places of arms the moſt diſtant from the town, ought to have a greater extent than thoſe which are neareſt, that the beſiegers may be able to take the enemy in flank, ſhould they reſolve to attack the neareſt parallels.

The trench ſhould be opened or begun as near as poſſible to the place, without expoſing the troops too much, in order to accelerate and diminiſh the operations of the ſiege.

There is no ſuch thing as giving any exact rule in regard to the diſtance which ought to be obſerved on opening the trenches. On level ground, this diſtance may be 800 or 900 fathoms; but if there ſhould be a hollow way in the vicinity of the place, the beſiegers are to take advantage of it, and open the trenches nearer. In general, they are to regulate themſelves according to the nature of the ground, more or leſs favourable to the opening of the trenches. We ſhall ſuppoſe in the preſent work, that the opening ought to be made within 800 fathoms of the covert way; the firſt parallel within 300 fathoms, the ſecond within 150, and the third at the foot of the glacis.

Care muſt be taken to join the attacks, that they may be able to ſupport each other.

Never to advance a work unleſs it be well ſupported; and for this reaſon, in the interval between the ſecond and third places of arms, the beſiegers ſhould make, on both ſides of the trenches, ſmaller places of arms, extending 40 or 50 fathoms in length, parallel to the others, and conſtructed in the ſame manner, which will ſerve to lodge the ſoldiers who are to protect the works deſigned to reach the third place of arms.

The batteries of cannon muſt be placed in the continuations of the faces of the pieces attacked, to ſilence their fire, and that the approaches being protected, may advance with greater ſafety and expedition.

For this reaſon the beſiegers ſhould always embrace the whole front attacked, to have as much ſpace as is requiſite to plant the batteries on the produced faces of the works attacked.

The attack muſt not be commenced with works that lie cloſe to each other, or with re-entrant angles, which would expoſe the attack to the croſs fire of the enemy.

54 General remarks on the defence of fortified towns.

Many circumſtances reſpecting the defence of fortified towns have already been anticipated, or may be collected from what has been ſaid reſpecting the operations of the beſieging army. It is evident that the ſucceſs or duration of the defence will depend in a great meaſure on the nature and ſtrength of the works which form the fortification. Much, however, will alſo depend on the number, reſolution, and reſources of the garriſon, and on the movements of the friendly army by which the beſiegers may be oppoſed. It is eſtimated by M. Vauban, that the operations for a regular ſiege of a well fortified town, will take up about 41 days, before the place can be carried by aſſault. Hence is deduced a computation of the quantity of proviſions, ammunition, and ſtores which ought to be collected for maintaining the ſiege. The ſame celebrated engineer calculates that the garriſon ought to conſiſt of 600 times as many men as there are baſtions in the fortification, allowing 600 men to each baſtion. Beſides the neceſſary defence of the works by the cannon on the ramparts, and the muſketry of the ſoldiers, the garriſon muſt make occaſional ſallies; if weak, to diſturb the operations of the beſiegers, and if very ſtrong, to engage them in the field. As the ſiege advances, and the attacking army approaches the glacis, mines ſhould be ſprung, and ſubterraneous paſſages excavated, to deſtroy the enemy's works, or cut off a part of their men.

55 Reference to authors on military tactics.

Towards ſupplying the unavoidable deficiencies in the above ſketch of military tactics, we may refer our readers to Clairac's *Field Engineer*, tranſlated by Muller; Le Cointe, *Science des Poſtes Militaires*, or the Engliſh tranſlation; Jeney's work entitled *Le Partiſan*, alſo tranſlated into Engliſh; O'Rourke's *Treatiſe on the Art of War*; *Eſſai General de Tactique*; Tielke *on the Art of War*, and his *Field Engineer*; Dundas's *Principles of Military Movements*; Landmann's *Elements of Tactics*; Maizeroy's *Syſteme de Tactique*; *Archives Militaires*; Feuquiere's *Memoires*; Bland on *Military Diſcipline*; *Military Inſtructions for Officers detached in the field*; and the articles BATTALION and BATTLE in Rees's *Cyclopædia*.

PART II. NAVAL TACTICS.

BY naval tactics is underſtood the art of arranging fleets or ſquadrons in ſuch an order or diſpoſition as may be moſt convenient for attacking the enemy, defending themſelves, or of retreating with the greateſt advantage. Naval tactics are founded on thoſe principles which time and experience have enabled us to deduce from

from the improved ſtate of modern naval warfare, which has occaſioned, not only a difference in the mode of conſtructing and working ſhips, but even in in the total diſpoſition and regulation of fleets and ſquadrons.

In the preſent part we propoſe to lay down the general principles of naval tactics, and to deſcribe as briefly as is conſiſtent with perſpicuity, the moſt improved ſyſtems which are now adopted in the French and Britiſh navy. As we have elſewhere (ſee NAVIGATION and SEAMANSHIP) detailed the methods of working ſingle ſhips, as they are unconnected with military operations, we ſhall preſume that our readers are already acquainted with theſe ordinary movements.

56 Ordinary diviſion of fleets.

Fleets are generally divided into three ſquadrons, the van, centre, and rear, each under the command of a flag officer. The admiral of the fleet, or chief in command, leads the centre diviſion, while the van is uſually commanded by a vice-admiral, and the rear by a rear-admiral. Each ſquadron is diſtinguiſhed by the poſition of the colours in the ſhips of which it is compoſed. Thus, the ſhips of the centre ſquadron carry their pendants at the main-top-gallant maſt-head; while thoſe of the van diviſion have their pendants at the fore-top-gallant maſt-head, and thoſe of the rear at the mizen-top-maſt-head. Each ſquadron, as far as poſſible, conſiſts of the ſame number of ſhips, and as nearly as may be of the ſame force. In large fleets, the ſquadrons are ſometimes again divided in a ſimilar manner; the van and rear of the ſquadron being headed by rear-admirals, or ſenior captains, called commodores. In the uſual mode of forming the lines, each commanding admiral arranges his ſhip in the centre of his own ſquadron, and thus the admiral of the fleet is in the centre of the line. When no enemy is in ſight, the ſloops, ſtore-ſhips, fire-ſhips, and other ſmall veſſels, are diſperſed to windward of the fleet, that they may be more eaſily ſupported, and more readily anſwer ſignals. The frigates lie to windward of the van and rear of the convoy, thus keeping a good look-out, and keeping the ſmall veſſels in their proper ſtation. When ſailing in three columns, the centre ſtill keeps in the middle, while the van and rear form the ſtarboard or the larboard column, according to circumſtances. Theſe arrangements are called orders of ſailing, and will be better underſtood from the following definitions.

57 Definitions.

The *ſtarboard line of bearing*, is that line on which the arranged ſhips of a fleet bear from each other, on a cloſe hauled line, whatever courſe they may be ſteering, ſo that when the ſhips haul their wind, or tack together, they may be on a line cloſe hauled upon the ſtarboard tack. The *larboard line of bearing* is that line on which the ſhips when hauling their wind, or tacking together, may be formed on a line cloſe hauled on the larboard tack. The ſhips of a fleet are ſaid to be *on a line abreaſt*, when their keels are parallel to each other, and their mainmaſts lie in the ſame ſtraight line. Ships are ſaid to lie in a line on the bow or quarter, when they are arranged in a ſtraight line, cutting their keels obliquely in the ſame angle, ſo that reckoning from any intermediate ſhip, the ſhips towards one extremity of the line will be on the bow of that ſhip, while thoſe towards the other extremity will be on her quarter. When ſeveral ſhips in the ſame line ſteer the ſame courſe, while that courſe is different from the line of ſailing, they are ſaid to ſail chequerwiſe.

When the ſhips of a fleet arranged in any of the orders of ſailing, and on the ſame line, perform ſucceſſively the ſame manœuvre, as each gets into the wake of the ſhip that leads the van of the line or ſquadron, tacking or veering, bearing away or coming to the wind in the ſame point of the wake of the leading ſhip, they are ſaid to *manœuvre in ſucceſſion*.

58 Illuſtration of the five orders of ſailing. Plate DLXIV.

There are uſually reckoned five orders of ſailing, excluſive of the line of battle, the order of retreat, &c. In the firſt order (ſee Plate DLXIV. fig. 1. and 2.) the fleet is arranged on the *ſtarboard* or *larboard* line of bearing, all the ſhips ſteering the ſame courſe. In theſe caſes the fleet, by hauling the wind when in the ſtarboard line, as in fig. 1. will be ready to form the line on the ſtarboard tack; and when ranged on the larboard line of bearing, as in fig. 2. it will, by tacking, be ready to form the line on the larboard tack. N. B. The arrows annexed to the diagrams on the plates, mark the direction of the wind, as in ordinary charts. Fig. 1. and 2.

This firſt order of ſailing is now ſeldom employed, except in paſſing through a narrow ſtrait. In the ſecond order of ſailing, the fleet ſteering any proper courſe, is ranged in a line perpendicular to the direction of the wind, as in fig. 3. This ſecond order, beſides being equally defective with the former, is ſubject to the additional diſadvantage of rendering it extremely difficult for the ſhips to tack, without each ſhip falling on board that next a-ſtern. Fig. 3.

In the third order of ſailing, the whole fleet is cloſe hauled, and ranged on the two lines of bearing, ſo as to form an angle of 12 points, having the admiral's ſhip (A fig. 4.) in the angular point, and the whole fleet ſteering the ſame courſe. Thus, ſuppoſing, as in the plate, the wind at north, the ſtarboard diviſion of the fleet will bear W. N. W. of the admiral, and the larboard E. N. E. This order in ſmall fleets or ſquadrons, is ſuperior to either of the former; but when the fleet is numerous, the line will be too much extended. Fig. 4.

In the fourth order, the fleet is divided into ſix or more columns, and is thus more concentrated. The commanders, ranged on the two lines of bearing, have their ſquadrons aſtern of them on two lines parallel to the direction of the wind; the firſt ſhips of each column being, with reſpect to the commander of the ſquadron, the one on his ſtarboard, and the other on his larboard quarter. The diſtance between the columns ſhould be ſuch that the fleet may readily be reduced to the third order of ſailing, and from that to the order of battle. This order is adapted for fleets or convoys croſſing the ocean, and is repreſented in fig. 5. But as it requires much time to reduce a fleet from this order to that of battle, it is defective when in preſence of an enemy. Fig. 5.

In the fifth order, the fleet, cloſe hauled, is arranged in three columns parallel to each other; the van commonly forming the weather, and the rear the lee column. See fig. 6. Fig. 7. repreſents the ſame order, except that each column is here ſubdivided into two, with the ſhip bearing the commander of each ſquadron in the centre of each ſubdiviſion. Fig 6. and 7.

59 Order of battle.

In forming the order or line of battle, the ſhips of the fleet are drawn up in a line nearly cloſe hauled,

ſtanding

Plate DLXIV. Fig. 8.

ſtanding under eaſy ſail, ſo that each ſhip may be at a certain diſtance from the ſhip immediately a-head, as a cable's length, or half that diſtance. The fireſhips and frigates a-head and aſtern, form a line parallel to the former, and to the windward of it, if the enemy be to the leeward; but to the leeward if the enemy be to windward. This order is denoted by fig. 8. where the fleet is ſailing on the ſtarboard tack, with the wind at north.

60 Order of retreat.

When a fleet is compelled to retreat before a ſuperior force, it is uſually arranged in an order, the reverſe of the third order of ſailing; the diviſions of the fleet being ranged in the two lines of bearing, ſo as to form an angle of 135° or 12 points, the admirals ſhips being in the angular point, and the frigates, tranſports, &c. included within the wings to leeward. See fig. 9. where the fleet is ſailing right before the wind. Though any other direction may be taken, the two lines ſtill form the ſame angle.

Fig. 9.

61 Order of convoy.

The order of convoy is that in which the ſhips are all in each others wake, ſteering in the ſame point of the compaſs, and forming a right line. If the fleet is numerous, it may be divided into three columns, which are to be ranged parallel to each other, that of the admirable occupying the centre, and all ſteering the ſame courſe.

Having thus deſcribed the ordinary poſitions of a fleet, we muſt explain the manœuvres by which they are produced, and we ſhall begin with the orders of ſailing.

62 Method of forming the firſt order of ſailing.

To form a fleet in the firſt order of ſailing, ſuppoſing the ſhips to be in no particular order, that ſhip which is to lead on the propoſed line of bearing for the order of ſailing, runs to leeward of the greater part of the fleet, and then hauls her wind under an eaſy ſail. Each of the other ſhips then proceeds to take the proper ſtation, by chaſing the ſhip, which is to be a-head of her, and when in the wake of the leading ſhip, adjuſts her quantity of canvas ſo as to preſerve the proper diſtance. The ſhips thus arranged aſtern of each other, are in the line of battle, and from this the firſt order of ſailing is formed, by each ſhip bearing away at the ſame time, and all ſteering the propoſed courſe.

63 Second order of ſailing.

In forming the ſecond order of ſailing, the leading ſhip runs to leeward of ſo many of the fleet as that each ſhip may readily fetch her wake, and then ſteers a courſe eight points from the wind, under an eaſy ſail. The line is formed by each ſhip in the ſame manner as in the firſt order, except that before bearing away, the line is perpendicular to the direction of the wind, or each ſhip has the wind on her beam.

64 Third order.

As, in the third order of ſailing, the admiral's ſhip is in the centre; to produce this poſition, the fleet being formed in a line on one of the lines of bearing, and the ſhips ſteering in each others wake, ten points from the wind, the leading or leewardmoſt ſhip firſt hauls her wind. The ſecond ſhip does the ſame as ſoon as ſhe gets into the wake of the former, and this is done by each ſhip till the admirals ſhips haul their wind, when they reach the wake of the leading ſhip. At the ſame time that the admiral's ſhip hauls her wind, the ſternmoſt half of the fleet does the ſame. The ſhips are now in the third order of ſailing, from which the fleet can be formed in line of battle on either tack.

65 Fourth order.

To form the fourth order of ſailing (ſee N° 58.), the commanding admirals range themſelves on the two lines of bearing, at a proper diſtance from each other, ſteering the propoſed courſe, and the ſhips of the ſeveral columns take each their reſpective places, parallel to each other, and forming lines in the direction of the wind.

66 Fifth order.

To form the fifth order, the three leading ſhips of the diviſions take their poſts abreaſt and to leeward of each other, keeping their wind under an eaſy ſail; then the ſhips of each ſquadron make ſail, and take their reſpective ſtations at the proper diſtance aſtern of their leaders, while the commanders of each diviſion, and the correſponding ſhips of each, keep mutually abreaſt of each other.

67 To form the line of battle.

In forming from the firſt order of ſailing, if the ſhips are running large on the tack that anſwers to the line of bearing on which they ſail, and if the line is to be formed on the ſame tack, all the ſhips haul their wind at once, or as quickly as poſſible after the next to windward; but if they be on the other tack, with reſpect to the line of bearing, they all haul their wind and tack or veer together. If the line of battle is to be formed on the other line of bearing, the ſhip moſt to leeward veers or tacks, and hauls her wind, while the reſt of the fleet veer or tack at the ſame time, and ſteer with the wind four points free, and each ſhip hauls her wind as ſoon as ſhe gets within the wake of the leader. See fig. 10. Plate DLXIV. and fig. 1. Plate DLXV.

Fig. 10. Plate DLXV. Fig. 1.

Suppoſe the fleet running before the wind in the ſecond order of ſailing; to form the line from this poſition, all the ſhips haul up together on the proper tack, preſenting their heads eight points from the wind at the line on which they are arranged; the leading ſhip then hauls her wind, immediately making ſail, or ſhortening ſail, ſo as to cloſe or open the order, and the ſame is done ſucceſſively by all the reſt (ſee fig. 2.).

Fig. 2.

In a fleet running large in the third order, the line of battle is formed by the wing which is in the line of bearing correſponding to the tack on which the line is to be formed, and the ſhip at the angle hauling their wind together, while the ſhips of the other wing haul up together eight points from the wind. Each ſhip moving in this direction, till ſhe reach the wake of the other wing, when ſhe hauls cloſe up (ſee fig. 3.).

Fig. 3.

In forming the line of battle on the ſame tack from the fifth order of ſailing (as the fourth is not calculated for forming a line of battle), the centre brings to, ſo as only to keep ſteerage way; the weather column bears away two points, and when it gets a-head of the centre, hauls its wind, while the ſhips of the lee column tack together, and crowd ſail to gain the wake of the centre, when they retack together, and complete the line (ſee fig. 4.); or, the weather column brings to, while the centre and lee tack together, and bear away two points free. When the ſhips of the centre column have gained the wake of the van, they retack together, and bring to; and when thoſe of the lee have gained the rear line, they retack together, and all ſtand on; or laſtly, the lee column brings to, the centre runs under eaſy ſail two points free, to get a-head of the rear ſquadron, while the rear bears away under a preſs of ſail two points free, to get ahead of the centre diviſion.

Fig. 4.

2. Suppoſe the weather and centre columns to interchange. To form the line under theſe circumſtances; the centre ſtands on, while the weather column bears away eight points,

points, and having reached the wake of the centre, which now forms the van, hauls up; the ſhips of the lee column tack together, and run under a preſs of ſail, within two points free, ſo as juſt to gain the rear of the line; when they retack together (ſee fig. 5.), or the lee column brings to, while the centre ſquadron bears away three points under eaſy ſail; and having reached the wake of the van, hauls up, to form the centre diviſion.

Plate DLXV. Fig 5.

3. Suppoſe the centre and lee columns to interchange. The lee column ſtands on cloſe hauled under an eaſy ſail, the weather column bears aways two points under a preſs of ſail, till it reach the head of the line, when it hauls up, and the centre bears away eight points, and when in the wake of the lee, now the centre, hauls its wind. (See fig. 6.). Fig. 6.

4. If the weather and lee columns interchange; the lee column ſtands on under a preſs of ſail cloſe hauled, while the centre, under eaſy ſail, bears away two points, and when it reaches the wake of the now van ſquadron, hauls its wind, and the weather column bears away eight points, hauling up when in the wake of the centre. (See fig. 7.). Fig. 7.

5. Suppoſe the centre column to form the van, and the weather the rear diviſion. Here the lee column brings to, while the centre bears away two points, forming the line a-head of the former, now the centre, and the weather column veers away ſeven points on the other tack, forming the rear ſquadron. (See fig. 1. Plate DLXVI.).

Plate DLXVI. Fig. 1.

6. To form the line ſo that the lee column may form the van, and the centre the rear. The lee column is to ſtand on under a preſs of ſail, while the weather bears away three points under eaſy ſail, and the centre bears away eight points, the ſhips of each column hauling their wind, when in the wake of the now van diviſion. (See fig. 2.). Fig. 2.

7. If the line of battle is to be formed on the other tack, ſo that the weather ſhall form the van diviſion, as in the firſt caſe, the ſhips of the weather column firſt tack ſucceſſively, while thoſe of the centre and lee ſtand on, the former under eaſy ſail, and the latter ſhortening ſail, the leading ſhips tacking when in the wake of the now van, taking great care that the ſhips of the centre and lee draw not too near to the ſternmoſt ſhips of the van, or to each other. (See fig. 3.). Fig. 3.

8. To form the line on the other tack, when the centre and weather columns interchange. The weather column brings to, while the centre column ſtands on, till the leading ſhip be fully able to clear the weather column, when the ſhips of the centre tack ſucceſſively as they reach the wake of the van. The lee column ſtands on, tacking ſucceſſively, as the ſhips get into the wake of the van, under moderate ſail. (See fig. 4.). Fig. 4.

9. In forming the line on the other tack, when the centre and lee interchange. The centre brings to, while the ſhips of the weather tack under ſhortened ſail, and the lee under a preſs of ſail ſtands on, the leading ſhip having gained the wake of the line, tacks, and is followed in ſucceſſion by her diviſion. The centre column fills and ſtands on, when the firſt ſhip of that column, and the laſt of the lee, bear from each other in a direction perpendicular to that of the wind. (See fig. 5.). Fig. 5.

10. To form on this ſame tack, ſo that the weather and lee may interchange. The weather and centre bring to, while the lee crowds ſail, till it can paſs a-head of the weather column, when the ſhips tack in ſucceſſion. As ſoon as the leading ſhip of the centre, and the laſt of the lee bear from each other in a line perpendicular to the wind, the centre fills, and tacks in ſucceſſion when in the wake of the now van, and the ſhips of the weather column do the ſame when their leading ſhip and the laſt of the centre are under ſimilar circumſtances. (See fig. 6.). Fig. 6.

11. Suppoſe the centre is to form the van, and the weather the rear, in forming the line on the other tack. The weather brings to, while the other columns make ſail, till they can paſs a-head of the former on the other tack, when they tack ſucceſſively. The weather column, when the others have paſſed it, fills, and tacks to form the rear. (See fig. 7.) Fig. 7.

12. Suppoſe now the lee column is to form the van. The weather and centre bring to, while the lee crowds ſail, and tacks when it can paſs a-head of the weather column. When the laſt ſhip of the now van has paſſed to windward of the former weather column, the van ſhortens ſail, to give time for the other columns to form, and the weather and centre fill at the ſame time, to gain the wake of the van, when they tack in ſucceſſion. (See fig. 8.). Fig. 8.

68
To form the orders of ſailing from the line of battle.

We muſt now ſhew how a fleet may be diſpoſed in the principal orders of ſailing from the line of battle; and here, as before, we have ſeveral varieties.

1. To form the firſt order of ſailing from the line of battle on the ſame tack. All the ſhips are to bear away together as many points as the admiral may direct, keeping in the line of bearing for the proper tack. The ſternmoſt firſt bears away, and the others follow in quick ſucceſſion, to prevent running foul of each other.

2. If they are to form on the other tack; the leading ſhip bears away four points to leeward, and the reſt follow in ſucceſſion. The ſternmoſt ſhip having bore away, the whole haul up, and will be in bearing for the line on the other tack. (See fig. 9.). Fig. 9.

3. To form the ſecond order of ſailing from the line of battle, the whole fleet is to bear away together 10 points, ſo that when the headmoſt ſhip, which firſt preſſes ſail, ſhall come abreaſt of the ſecond ſhip, the ſecond ſhip adapts her ſail to keep in this bearing, and ſo in ſucceſſion, each taking care to keep the preceding ſhip in a line with herſelf, perpendicular to the direction of the wind. The whole fleet will now be before the wind. (See fig. 10.). Fig. 10.

4. To form the third order, the whole fleet is to bear away together ten points, the headmoſt half, including the centre ſhip, carrying a degree of ſail to preſerve their line of bearing, while each of the remaining ſhips is ſucceſſively to ſhorten ſail, ſo as to form the other line of bearing with reſpect to that on which they were before arranged. (See fig. 1. Plate DLXVII.).

Plate DLXVII. Fig. 1.

5. To change from the line of battle to the fifth order on the ſame tack. Of this evolution there are ſeveral varieties, but we ſhall mention only two; firſt, when the van is to form the weather, and the rear the lee column, and the fleet to keep as much as poſſible to windward.—In this caſe the van and centre tack together, and run cloſe hauled in bow and quarter line, while the rear proceeds in its former courſe under eaſy ſail. When each ſhip of the centre is abreaſt of the correſponding ſhip of the rear, the centre retacks, while

Plate DLXVII. Fig. 2.

while the van ſtands on, till the centre and rear come up, when it alſo retacks, and all the columns regulate their diſtances. (See fig. 2.). Secondly, when the van is to form the lee, and the rear the weather column.—The van bears away under eaſy ſail, and goes at right angles with the line a-head, while the centre runs two points free, each ſhip ſteering for that ſhip of the van which is to be a-breaſt of her when in column. The diſtance muſt be determined by the leader of the van, who is not to haul up with her diviſion, till ſhe and the ſternmoſt ſhip of the centre column are in a line at right angles with the wind, when both ſtand on under eaſy ſail, while the rear crowds ſail to paſs to windward of both. (See fig. 3.). Fig. 3.

6. To form the fifth order of ſailing from the line of battle on the other tack—of which there are alſo ſeveral varieties; but we ſhall confine ourſelves to two: Firſt, when the van is to form the weather, and the rear the lee column; the van tacks in ſucceſſion, while the leading ſhip of the centre is to tack when the leader of the van paſſes him exactly to windward, in which ſhe is followed by her diviſion, and the rear manœuvres in the ſame manner with reſpect to the centre. (See fig. 4.). Fig. 4. Secondly, when the rear is to form the weather and the van the lee column; the van tacks in ſucceſſion, and when about, either ſhortens ſail, or brings to, to allow the other columns time to form. The centre and rear then crowd ſail, and tack in ſucceſſion, the former tacking when its leader has the centre of the lee column in a line at right angles with the wind, or when its centre paſſes a-ſtern of the lee column. When the centre has tacked, it regulates its rate of ſailing by the lee, and both wait for the rear to paſs to windward. The rear tacks when the leader has the firſt ſhip of the lee in a line at right angles with the wind, or when its centre ſhip paſſes a-ſtern of the centre column. (See fig. 5.). Fig. 5.

Fig. 6. 7. Fig. 6. repreſents the order of retreat formed from the line of battle, the whole fleet going four points free. This evolution is ſo ſeldom required in a Britiſh fleet, that we need not dwell on it.

69
To manœuvre in line of battle.

There are various evolutions or manœuvres performed by a fleet when in line of battle, ſome of which we muſt here deſcribe.

Sometimes the fleet has to form the line on the other tack, by tacking in ſucceſſion. To do this, the leading ſhip of the fleet tacks firſt, after making more ſail, or after the ſecond has ſhortened ſail, to increaſe the interval between them. When the firſt ſhip is about, either the ſecond makes more ſail, or the third ſhortens ſail, and as ſoon as the ſecond gets into the wake of the leader, ſhe tacks, putting down the helm juſt as ſhe opens the weather quarter of the firſt ſhip, already on the other tack. In the ſame manner, each of the other ſhips tacks when in the wake of the leader; and the ſhips already about muſt preſerve their proper diſtances, by ſhortening ſail, if neceſſary, till the whole fleet be on the other tack. If a ſhip ſhould miſs ſtays, ſhe muſt immediately fill again on the ſame tack, and make ſail with all poſſible expedition, taking care not to fall to leeward. Thus ſhe will get a-head, and to windward of the following ſhips, which will ſucceſſively perform their evolutions in the wake of the ſhips that are already on the other tack, ſtanding on rather further than if the ſhip a-head had not miſſed ſtays. (See fig. 7.). Fig. 7.

But ſuppoſe the ſhips are not to tack in ſucceſſion. To form the line on the other tack, the whole fleet veers together; the rear ſhip hauls her wind on the other tack, and ſtands on, while the reſt go two points free on the other tack, and haul up as they ſucceſſively gain the wake of the leading ſhip. (See fig. 8.). Fig. 8.

If the line is to veer in ſucceſſion, the van ſhip veers, and ſtands four points free on the other tack, hauling her wind when clear of the ſternmoſt ſhip, and the reſt follow and haul up in ſucceſſion. (See fig. 9.). Fig. 9.

Sometimes the fleet has to turn to windward while in line of battle. The beſt way to do this, when there is good ſea-room, is for all the ſhips to tack together, when the fleet will be in line of battle on the one board, and in bow and quarter line on the other. If, however, the fleet be turning to windward in a narrow channel, it is beſt for the ſhips to tack in ſucceſſion, as, were they all to tack together, the van would be ſoon in with the land on one ſide, while the ſtern ſhip, ſoon after the fleet had retacked, would be too near the land on the other ſide.

If the van and centre are to interchange; the van is to bear away a little, and then bring to, while the centre paſſes on to windward, edging a little, to get a-head of the former van on the ſame line; the rear, coming on under an eaſy ſail, edges away likewiſe, to gain the wake of the now centre ſquadron. (See fig. 10.). Fig. 10.

If the van and rear are to interchange; the van and centre are to bear away a little, and then bring to, ſo that the van may bear away a little more to the leeward than the centre. The rear ſtands on to gain the head of the line; and when a-breaſt of the former van, the centre fills, and both ſtanding on, form a-head of the now rear, by edging down till they are in a line with it. (See fig. 11.). Fig. 11.

If the centre and rear are to interchange; the van ſtands on under an eaſy ſail, while the centre bears away a little, and brings to, and the rear at the ſame time carries a preſs of ſail to paſs the centre to windward, and get into the wake of the van. The van and centre then edge away to gain the line, with the now rear ſquadron, which then fills. (See fig. 12.). Fig. 12.

70
To manœuvre in the fifth order of ſailing.

Several evolutions are required while a fleet is in the fifth order of ſailing, and of theſe we ſhall notice ſome of the more important.

When the columns are to tack in ſucceſſion, the ſhips of the lee muſt tack firſt, as they have moſt diſtance to run, and when the leader of the centre comes a-breaſt of the leader to leeward, or at right angles with the cloſe-hauled line on the other tack on which the leader of the lee is now moving, ſhe tacks and is followed ſucceſſively by the ſhips of her diviſion. The weather column manœuvres in the ſame manner, paying the ſame regard to the centre. Here the weather column is ſtill to windward, and ſhould the columns have cloſed too much, or be too far aſunder, the order may be recovered, either by the lee or windward column bearing away, ſo as to make an angle equal to that propoſed between any column, and a line joining the leader of that column, and the ſternmoſt ſhip of the next. (See fig. 13.). Fig. 13.

When all the columns are to tack together; the ſternmoſt ſhips put in ſtays together; and when in ſtays, their ſeconds a-head put down their helms, and ſo on through the whole fleet. Each column will then be in bow and quarter line. (See fig. 14.). Fig. 14.

When the columns are to veer in ſucceſſion; the leader of the lee column muſt ſteer four points free on the other tack, followed by the ſhips of that diviſion, and when ſhe is clear of the ſternmoſt ſhips of that diviſion, ſhe hauls up. The ſame evolution is performed by the centre and weather ſhips ſucceſſively, ſtanding on till they bring the point at which the lee column began to veer to bear in a right line to leeward of them. They likewiſe ſucceſſively ſpring their luffs when the point at which the lee column hauled its wind, bears right to leeward. (See fig. 15.).

Plate DLXVII. Fig. 15.

Suppoſe the fleet, when in the fifth order of ſailing is to turn to windward; let the ſhips be ſo arranged that the leaders and correſponding ſhips may be in the direction of the wind. The van ſhips muſt tack together, which are followed in ſucceſſion, each by the remaining ſhips of the diviſion, when they reach the wake of their leaders, or the ſame point when they tacked; ſo that there will always be three ſhips in ſtays at once, till the whole fleet is on the other tack. The fleet then ſtands on to any propoſed diſtance, and retacks as before. (See fig. 1. Plate DLXVIII.).

Plate DLXVIII. Fig. 1.

When the weather and centre columns interchange; the weather and lee lie to, or only keep ſteerage way. The centre column tacks together, and forming a bow and quarter line, goes cloſe hauled to gain the wake of the weather column; it then tacks together, and ſtands on, while the weather column bears away to its new ſtation in the centre, and the lee column fills. (See fig. 2.).

Fig. 2.

When the weather and lee columns are to interchange; the centre column muſt bring to; while the lee ſtands on under a preſs of ſail; and when its ſternmoſt ſhip can paſs to windward of the van of the centre column, that is, when the centre ſhip of the lee is in a perpendicular line to the direction of the wind with the van of the centre column, the lee column then tacks together, and ſtands on cloſe hauled till it comes in a line with the centre column, when it goes large two points to get into the ſituation which the weather column left; and then veers together, hauling the wind for the other tack. At the beginning of the evolution the weather column bears away together under little ſail, and goes large ſix points on the other tack, to get into the wake of the centre column; it then hauls to the former tack, going two points large, till it comes abreaſt of the centre column, when it brings to, and waits for the now weather column. (See fig. 3.).

Fig. 3.

Suppoſe the weather column is to paſs to leeward; the weather column is to ſtand on under eaſy ſail, while the centre and lee tack together, carrying a preſs of ſail till they reach the wake of the weather column, when they retack, and crowd ſail till they come up with it. The weather column, when the others have gained its wake, bears away two points, to gain its ſtation to leeward, when it brings to, till the other columns, now the weather and centre, come up. (See fig. 4.).

Fig. 4.

Suppoſe the lee column is to paſs to windward. The weather and centre columns bring to, while the lee column carries ſail and tacks in ſucceſſion (as ſoon as the leading ſhip can weather the headmoſt ſhip of the weather column; and when arrived on the line on which the weather column is formed, it retacks in ſucceſſion, forms on the ſame line, and either brings to or ſtands on under eaſy ſail. If it brings to, the other two columns bear away together two points, to put themſelves a-breaſt of the column now to windward; but if the now weather column ſtood on under an eaſy ſail, they may bear away only one point, to gain their proper ſtations. (See fig. 5.).

Fig. 5.

It is of the greateſt importance that each ſhip of a fleet or ſquadron preſerve her proper ſtation and diſtance with reſpect to the reſt. Theſe may be regulated in two ways, either by obſervation with the quadrant, or by what is called the *naval ſquare*. This ſquare is uſually conſtructed in the following manner.

71
Conſtruction and uſe of the naval ſquare.
Fig. 6.

On ſome convenient place in the middle of the quarter-deck is deſcribed the ſquare ABCD, fig. 6. having the ſides AD and BC parallel to the keel of the ſhip. Through the centre G, the line EF is drawn parallel to AD or BC, and the diagonals AC and BD are drawn. The angles EGD, EGC are biſected by the ſtraight lines GH, GI, and thus the naval ſquare is completed. Now the angles FGD, FGC are = 4 points each, being each half a right angle, therefore the angles EGD, EGC, the complements of theſe angles, are each = 12 points, and conſequently the angles EGH, EGI are each = 6 points, being each half of the laſt angles. Now, if a ſhip be running cloſe hauled on the ſtarboard tack, in the direction FE, the direction of the wind will be IG, and her cloſe hauled courſe on the other tack will be GC; but if ſhe be running cloſe hauled on the larboard tack in the ſame direction, her direction when cloſe hauled on the ſtarboard tack will be GD.

Now, to apply the naval ſquare to the keeping of ſhips in their reſpective ſtations, ſuppoſe the fleet formed on the fifth order of ſailing, cloſe hauled, the correſponding ſhips of the columns coinciding with the direction of the wind, in order to run to windward with greater facility. The correſponding ſhips in the column muſt be kept in the direction of GH, or GI, according to the direction of the wind and the tack they are on, while all the ſhips of the ſame column muſt be in the direction of EF. (See fig. 7.).

Fig. 7.

Again, ſuppoſe the ſhips arranged in three columns on one of the lines of bearing, and cloſe hauled on the other tack. The ſhips of each column will be in the direction of one of the diagonals, while the correſponding ſhips of the other columns will be in the direction of the other diagonal. (See fig. 8.).

Fig. 8.

72
To reſtore the order of battle, on ſhifts of the wind.

Sometimes the line of battle is diſordered on the wind's ſhifting, and requires to be reſtored. Of this there are ſeveral caſes, a few of which we ſhall notice.

1. When the wind comes forward leſs than 6 points. In this caſe the whole fleet except the leader brings to. The leading ſhip, that the ſame diſtances between the ſhips may be preſerved on reſtoring the line, ſteers a courſe as *a b* (fig. 9.), ſo as to be at right angles with the middle point between the former and preſent direction of the wind. His required courſe may be known by adding half the number of points the wind has ſhifted to eight points, and applying this ſum to the former cloſe-hauled courſe. When the leader has arrived at the new cloſe-hauled line with reſpect to the ſecond ſhip a-head, this ſhip immediately fills, and bears away as many points as the leader; and when both theſe have reached the cloſe-hauled line with reſpect to the third ſhip, ſhe alſo fills, and bears away; and thus with the reſt in ſucceſſion; and when they have got into the cloſe-hauled

Fig. 9.

Plate DLXVIII.

cloſe-hauled line *b c* with the ſternmoſt ſhip, they all haul their wind together, and the ſternmoſt ſhip fills and ſtands on cloſe hauled.

This may be expeditiouſly performed, if the whole fleet fall off as ſoon as the wind ſhifts, the ſame number of points, and the leader bear away eight points from the middle between the former and preſent directions of the wind, or when the wind ſhifts nearly ſix points, if the leader bear away eight points from the preſent direction of the wind, and hauls her wind as ſoon as the ſternmoſt ſhip bears from her in the cloſe-hauled line, while the ſecond ſhip bears away when ſhe reaches the wake of the leader, and hauls her wind when ſhe has again gained his wake. The third, fourth, &c. ſhips bear away, and alſo haul their wind in ſucceſſion, till the ſternmoſt and the whole line be formed again. (See fig. 10.). Fig. 10.

2. Suppoſe the wind comes forward leſs than ſix points, and the order of battle is to be re-formed on the other tack. In this caſe all the ſhips are to veer round till their heads come to the requiſite point with reſpect to their former courſe, when the rear ſhip, now become the van, hauls cloſe by the wind, followed ſucceſſively by the other ſhips. Should the wind come a-head more than ſix points, but leſs than twelve, the fleet is to manœuvre as before, but if it ſhift exactly twelve points a-head, the tack muſt be changed.

3. Laſtly, ſuppoſe the wind to ſhift oft—if leſs than two points, the leader hauls her wind, while the fleet ſtands on as before, each ſucceſſively hauling her wind as ſhe gains the wake of her leader. If the tack is to be changed, the whole fleet tack together, and the ſternmoſt ſhip, now the leader, hauls up, while the reſt bear down and haul up in ſucceſſion.

Should the wind change 16 points, all the ſhips immediately brace about for the other tack, by which means the fleet will be going four points large; then the ſhips inſtantly tacking or veering together, the order of battle will be reſtored or formed again on the ſame tack as before the wind changed.

It is inconſiſtent with the nature of our plan to be more minute on the various evolutions of a fleet, when not in action with the enemy. Our nautical readers will find abundant information of this kind in the uſual works on naval tactics, eſpecially the *Elements and Practice of Rigging, Seamanſhip, Naval Tactics*, &c. of which the lateſt edition is in 4 vols 8vo.; and *The Syſtem of Naval Tactics, with coloured figures*, both publiſhed by Steel.

Having deſcribed and illuſtrated the principal evolutions which are performed by fleets or ſquadrons under ordinary circumſtances, we are prepared to conſider the nature and conſequences of a naval engagement.

73
Circumſtances to be conſidered in forming a fleet for action.

In forming a fleet for battle, it is proper to conſider the ſize and number of the ſhips of which it is to conſiſt, and the diſtance at which they are to be placed with reſpect to each other. In the preſent ſyſtem of naval warfare, it is generally deemed of advantage to have the ſhips that are to form the principal line as large as poſſible; for though large ſhips are not ſo eaſily and expeditiouſly worked as thoſe of a ſmaller ſize, they are moſt ſerviceable during the action, both as carrying a greater weight of metal, and as being leſs expoſed to material injury, either from the enemy's ſhot, or from the weather. In boarding too, a large ſhip muſt have greatly the ſuperiority over a ſmaller, both from her greater height, and from the number of hands which ſhe contains. With reſpect to the number of ſhips, it is of advantage that they be not too numerous, as if the line be too extenſive, the ſignals from the centre are with difficulty obſerved.

In arranging a fleet in line of battle, it is proper to regulate the diſtance ſo that the ſhips ſhall be ſufficiently near to ſupport each other, but not ſo cloſe as that a diſabled ſhip may not readily be got out of the line without diſturbing the reſt of the fleet.

74
Advantages and diſadvantages of the weather gage.

It has long been deemed a point of great conſequence with the commander of a fleet to gain the weather gage, or to get to windward of the enemy, before coming to action. In deciding on the propriety of this, much will depend on the relative ſtrength of each fleet, and on the ſtate of the weather at the time. We ſhall ſtate the advantages and diſadvantages of the weather gage, as they are commonly laid down by writers on naval tactics, though we may obſerve by the way, that if a fleet be much ſuperior to its opponent, it is ſeldom of conſequence whether it engages to windward or to leeward.

A fleet to windward of the enemy is thought to poſſeſs the following advantages. It may approach the leeward fleet at pleaſure, and can of courſe accelerate or delay the beginning of the engagement. If more numerous, it may ſend down a detachment on the rear of the enemy, and thus throw him into confuſion. It may alſo readily ſend down fireſhips on the enemy's fleet, when thrown into confuſion or diſabled. It may board at any time, and is ſcarcely incommoded by the ſmoke of the enemy. The reverſe of theſe circumſtances, of courſe, act againſt a leeward fleet.

The diſadvantages of being to windward of the enemy reſpect chiefly the circumſtances attending a retreat, ſhould this be neceſſary. The windward fleet can ſeldom retire without paſſing through the enemy's line; and if in attempting to retreat, the windward ſhips tack together, thoſe of the leeward fleet may do the ſame, rake the weather ſhips in ſtays, and follow them on the other tack, having now the advantage of the wind. In ſtormy weather, the windward ſhips can ſeldom open their lower deck ports, and the lee guns are not eaſily managed after firing. Again, any diſabled ſhips cannot eaſily quit the line without diſordering the reſt of the fleet, and expoſing either that or themſelves to be raked by the enemy to leeward. A leeward fleet has the advantages of ſerving their lower-deck guns in all weathers; of being able to retreat at pleaſure; of drawing off without difficulty their diſabled ſhips; of forming with more readineſs the order of retreat, or of continuing the action as long as convenient; of having it in their power when ſuperior in number, to double the enemy, and of cannonading with great effect the windward ſhips as they bear down for the attack.

As an engagement between two adverſe ſhips is in ſome meaſure an epitome of an engagement between two fleets, we ſhall firſt briefly deſcribe the former, as it takes place under ordinary circumſtances, and ſhall then notice the uſual manner of conducting a general engagement.

A naval engagement may be divided into three ſtages, the *preparation*, the *action*, and the *repair*.

75 Deſcription of an engagement between two ſhips.

76 Preparation.

When an enemy's ſhip heaves in ſight, and it is thought adviſable to bring her to an engagement, orders are firſt given to clear for action, which is begun by the boatſwain and his mates piping up the hammocks, in order to clear the ſpace between decks, for the more eaſy management of the guns, as well as to afford the men on the quarter-deck, &c. a better protection againſt the enemy's ſhot, the hammocks being ſtowed in the nettings above the gunwale and bulwarks. After this, the boatſwain's mates go to work to ſecure the yards, which is done by faſtening them with ſtrong chains or ropes in addition to thoſe by which they are ſuſpended. They likewiſe get ready ſuch materials as may be neceſſary for repairing the rigging, if it ſhould be cut away, or otherwiſe damaged by the enemy's ſhot. In the mean time the carpenter and his mates prepare ſhot plugs and mauls, to ſtop any dangerous ſhot holes that may be made in the hull near the ſurface of the water, and provide the neceſſary iron work for refitting the chain-pumps, if their machinery ſhould be injured during the engagement; while the gunner and his mates, and the quarter gunners, examine the guns, to ſee that their charges are dry, and provide every thing that may be required for ſupplying the great guns and ſmall arms with ammunition. The maſter and maſter's mates ſee that the ſails are properly trimmed, according to the ſituation of the ſhip, and increaſe or reduce them as may be found neceſſary; and the lieutenants viſit the different decks, to ſee that all is clear, and to take care that the inferior officers do their duty.

When the hoſtile ſhips have approached within a proper diſtance of each other, the drums beat to arms; the boatſwain and his mates pipe *all hands to quarters!* All the men who are to manage the great guns repair immediately to their reſpective ſtations. The crows, handſpikes, rammers, ſponges, powder-horns, matches, and train tackles, are placed in order by the ſide of the guns: the hatches are immediately cloſed, to prevent ſculkers from getting below; the marines are drawn up on the quarter-deck, &c. the laſhings of the guns are caſt looſe, and the tompions withdrawn. The whole artillery, above and below, is run out at the ports, and levelled to the point blank range, ready for firing.

77 The action.

When theſe neceſſary preparations are completed, and the officers and crew ready at their reſpective ſtations, and when the two ſhips are ſufficiently near each other, in a proper relative ſituation for the ſhot to take full effect, the action commences with a vigorous cannonade from the great guns, accompanied by the whole efforts of the ſwivels and ſmall arms. The firing is ſeldom performed in vollies, as that would ſhake the ſhip too much, but the guns are loaded and fired one after another, with as much diſpatch and as little confuſion as poſſible, care being taken to fire only when each gun is properly directed to its object. During the firing, the lieutenants traverſe the decks, to ſee that the battle is proſecuted with vivacity, and that the men do their duty, while the midſhipmen ſecond their injunctions, and give the neceſſary aſſiſtance where required, at the guns committed to their charge. The youngeſt of theſe inferior officers are generally employed to carry orders from the captain. The gunners are all this time employed in the magazines, filling cartridges, which are carried along the decks in boxes by the boys of the ſhip. When the action has continued ſo long, or has produced ſuch an effect, that one of the ſhips muſt yield or retreat, if the vanquiſhed ſhip cannot get off, ſhe acknowledges her inferiority by ſtriking, or hauling down her colours, when ſhe is, as ſoon as poſſible, taken poſſeſſion of by the victor, the commander of which ſends a part of his own crew into the captured ſhip, and brings away moſt of her officers and men on board his own ſhip, as priſoners of war.

78 Repair.

The engagement being concluded, they begin to repair; the guns are ſecured by their breechings and tackles, with all convenient expedition. Whatever ſails have been rendered unſerviceable are unbent, and the wounded maſts and yards ſtruck upon deck, to be fiſhed or replaced by others. The ſtanding rigging is knotted, and the running rigging ſpliced where neceſſary. Proper ſails are bent in the room of thoſe which have been diſplaced as uſeleſs. The carpenter and his mates are employed in repairing the breaches made in the ſhip's hull, by ſhot plugs, pieces of plank, and ſheet lead. The gunner and his aſſiſtants are buſied in repleniſhing the allotted number of charged cartridges, to ſupply the place of thoſe which have been expended, and in refitting whatever furniture of the guns may have been damaged by the action.

79 Engagement between two fleets.

A general engagement between two adverſe fleets of courſe involves a greater variety of circumſtances, and requires greater judgement, and more comprehenſive ſkill in the commanding officer.

When the commander of a fleet has diſcovered an enemy's fleet, his principal object, if he be ſufficiently ſtrong, is to bring it to action as ſoon as poſſible. Every inferior conſideration gives way to this important object, and all neceſſary preparations are immediately made to prepare for ſuch an event. The ſtate of the wind and ſituation of the enemy will in general regulate his conduct with regard to the dipoſition of his ſhips on that occaſion. To facilitate the execution of the admiral's orders, the whole fleet is diſpoſed in three ſquadrons, and each of theſe claſſed into three diviſions, under the command of different officers. Before the action begins, the adverſe fleets are drawn up in two lines, as formerly deſcribed. As ſoon as the admiral diſplays the ſignal for the line of battle, the ſeveral diviſions ſeparate from the columns in which they were diſpoſed in the uſual order in ſailing, and every ſhip crouds ſail to get into its ſtation in the wake of the next a-head; and a proper diſtance from each other is regularly obſerved from the van to the rear. The admiral, however, occaſionally contracts or extends his line, ſo as to regulate the length of his line by that of his adverſary. This is more particularly neceſſary to prevent his being doubled, by which his van and rear would be thrown into diſorder. When the hoſtile fleets approach each other, the courſes are commonly hauled upon the brails, and the top-gallant ſails, and ſtay ſails furled. The movement of each ſhip is regulated chiefly by the main and fore-top ſails and the jib: the mizen-top ſail being reſerved to haſten or retard the courſe of the ſhip; and by filling or backing, hoiſting or lowering it, to determine her velocity. The ſignal for a general engagement is uſually diſplayed when the fleets are ſufficiently near each other, to be within the range of point-blank ſhot, ſo that the guns may be levelled with ſome certainty of execution. After the battle has commenced, it is carried on much in the ſame manner as between two ſhips, except that each

veſſel

veſſel of the fleet, beſides attending to her own movements, has to obſerve the ſignals made by the commanding officer, and repeated by the frigates on the van and rear. The chief object of the admiral is to keep his line as complete as poſſible, by ordering ſhips from thoſe in reſerve to ſupply the place of ſuch as may have been diſabled, and to annoy the enemy as much as poſſible, both by ſtrengthening the feeble parts of his own line, and, if circumſtances admit of it, by ſending down fire-ſhips upon that of the enemy. When the engagement draws near a cloſe, either by the defeat of the enemy, or by the diſabled ſtate of either fleet, ſignals are made from the admiral, to take poſſeſſion of ſuch of the enemy's ſhips as have ſtruck, to tow his own diſabled ſhips into a place of ſecurity, and either to chaſe the remainder of the enemy's ſquadron, or, if that be impracticable, to draw off his own ſhips to be refitted. *

Such are the general incidents attending an engagement at ſea, modified of courſe by numerous circumſtances, of which a general deſcription can convey no idea. There are, however, various movements and evolutions connected with a naval engagement, which it will be neceſſary for us to notice.

80 To diſpute the weather gage with an enemy.

Where the weather gage is deemed of ſufficient importance, it is often an object with two fleets to diſpute it with each other. When the enemy is to windward, and it is wiſhed to gain the weather-gage of him, the fleet to leeward ſhould avoid extending itſelf the length of the enemy's line, in order to oblige them to edge down upon theirs, if they intend to attack them; which will be a mean, if they ſtill perſiſt in doing ſo, of loſing the advantage of the wind. It is impoſſible for a fleet to leeward to gain to windward, ſo long as the enemy keep the wind, unleſs a change happens in their favour; therefore all that a fleet to leeward can do muſt be to wait with patience for ſuch a change, of which they will undoubtedly avail themſelves, as well as of any inadvertency the enemy may commit in the mean time. And as long as the fleet to leeward does not extend its line the length of the enemy's, it will be impoſſible for the latter to bring them to action without running the hazard, by bearing down, of loſing the advantage of the wind, which both fleets will be ſo deſirous of preſerving. That an admiral may take advantage of ſuch ſhifts of wind as occaſionally happen, he muſt endeavour to get his ſhips into ſuch ſituations where theſe ſhifts moſt frequently take place. It is well known to experienced naval officers, that particular winds reign moſt on certain coaſts, or off certain headlands. Here, therefore, the admiral ſhould await the approach of the enemy; and though by this plan he may ſometimes be unſucceſsful, he will more frequently gain a material advantage. The diſpoſition of projecting headlands, and the ſetting of tides or currents, often contribute materially towards gaining the wind of the enemy. The fleet to windward ſhould keep that to leeward as much as poſſible abreaſt of it; and thus, unleſs the wind changes conſiderably, they will preſerve the advantage they have gained. They ſhould alſo force them to keep their wind, unleſs they think it prudent not to engage, in which caſe it would be better to keep altogether out of ſight.

81 To force the enemy to action.

When the enemy appears deſirous of avoiding an action, there are various methods of attempting to force him to engage; as firſt, when he has the weather gage. In this caſe the lee fleet, which is deſirous of bringing on an engagement, muſt keep always on the ſame tack with the enemy to windward, taking care to keep their own ſhips ſo exactly abreaſt of the enemy, as to prevent loſing ſight of them; and hence be ready to take advantage of the firſt favourable ſhift of wind to make the attack. An alteration of the courſe may be beſt attempted in the night. The lee fleet muſt have frigates on the look-out, and theſe muſt continually give notice by ſignal of the manœuvres and courſe of the retreating fleet to windward. Thus the weather fleet is always expoſed to purſuit, without being able to get off unſeen; hence muſt ſooner or later be compelled to an engagement, unleſs they can get into ſome friendly port, or ſhould be favoured by a gale of wind ſufficient to diſperſe both fleets, and thus prevent the poſſibility of a general engagement.

Secondly, when the enemy is to leeward.—If the lee fleet keep cloſe to the wind in the order of battle, the fleet to windward is to ſtand on in the ſame manner till it be abreaſt of the enemy, ſhip to ſhip, and at the ſame time to bear away, and ſteer ſo as to bring their reſpective opponents on the ſame point of the compaſs with themſelves. Thus the adverſe fleets will be ſufficiently near each other to begin the action, by each ſhip's preſenting her bow to the ſhip abreaſt of her in the order of ſailing, which may be eaſily changed for the order of battle, by all the ſhips hauling together cloſe to the wind, in the moment which precedes the action. If the fleet to leeward appear inclined to engage, it may bring to, to prevent loſing time, and after this they will fill as ſoon as the action commences, becauſe it is of advantage to a lee line to be advancing ahead. As the lee fleet fills and ſtands in cloſe by the wind, the weather line ſhould keep abreaſt, before it bears away, to come within the requiſite diſtance, that the van ſhip of the weather fleet may always keep to windward of the leading ſhip of the lee line, and be guarded againſt any ſhift of wind ahead.

If the lee fleet bear away four points to move their order of battle on the other tack, and avoid the action, filing off in ſucceſſion in the wake of the van ſhip, the weather line, by bearing away all together eight points, cannot fail, as both fleets are ſuppoſed to ſail equally, to paſs through the middle of their line, and force them to fight with diſadvantage, if their extent be double the diſtance between the two fleets. If the extent of the fleet be leſs than the above limitation, then the weather fleet will divide the lee fleet more unequally; and if the diſtance between the fleets be conſiderable, the weather fleet will be able to break through the line. If the lee fleet bear away four points all together, being of equal extent with the fleet to windward, and their diſtance from each other equal to that of the length of one of the lines; ſhould the weather fleet bear away at the ſame time eight points, they will approach very near the ſternmoſt of the retreating fleet; but they will not have it in their power to cut off any part of that fleet, even with an equality of ſailing; ſo that the only advantage gained by this manœuvre will be an ability of attacking the rear, and bringing it to action.

If the van ſhip and the reſt of the weather fleet had a ſufficient velocity to keep the centre ſhip of the lee line on the ſame point of bearing; in that caſe, the leading ſhip may break through the enemy's line about the

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* For particular Britiſh naval actions, ſee *Campbells Lives of the Admirals*, and *Beatſon's Naval and Military Memoirs of Great Britain.*

middle ſhip of the centre diviſion; for, ſuppoſing the fleets in the order of battle, on the ſtarboard tack, ſteering eaſt, with the wind at ſouth ſouth-eaſt, being at two leagues diſtance from each other, both the lines being four leagues in extent; then the lee line bearing away all together four points, will run north-eaſt; while the fleet to windward, bearing away all together eight points, will ſteer north; the van ſhip of which will keep the centre diviſion of the lee line in the point of bearing north-weſt. As ſhe is ſuppoſed to be able to continue in this poſition, it follows, that the van of the weather line muſt cloſe the centre of the flying line to leeward, after having run four leagues. The time and diſtance neceſſary to cut off a retreating fleet may always be known according to the laſt ſuppoſition. If the lee fleet ſhould get on the other tack, and run large, ſtill in the order of battle, they will be ſooner forced to action by the weather fleet, who have only to bear away eight or nine points on the ſame tack, or run right before the wind.

81 To avoid coming to action.

As in forcing a fleet to action, there are two principal caſes in which a fleet may avoid an action, where circumſtances are not ſufficiently favourable; firſt, when the enemy is to windward, and ſecondly, when he is to leeward. In the former caſe the lee fleet ſhould form the order of retreat, if the enemy are in view, and run on the ſame tack as their leading ſhip; but if he is ſtill out of ſight, and they have received intelligence of his approach, by their frigates on the look-out, they may bear away large, without confining themſelves to keep the wind directly off, unleſs when in the order of retreat. In the ſecond caſe, it ſeldom happens that the weather fleet can be forced to an engagement, becauſe it can always ſtand on that tack which increaſes its diſtance from the enemy; that is, by ſtanding on one tack while the enemy is on the other. The windward fleet muſt of courſe not keep too near the enemy, and take all poſſible means of avoiding being abreaſt of him.

82 To double an enemy.

It is often of advantage to double the enemy; that is, to bring a part of the fleet round upon his van or rear, ſo as to place him between two fires. This manœuvre alſo reſolves itſelf into two principal caſes: firſt, when the enemy is to windward; ſecondly, when he is to leeward. In the firſt caſe, the lee fleet that attempts to double the enemy, ſhould extend itſelf abreaſt of him, ſo that its van or rear may extend beyond his line, in order to overreach him, by tacking in ſucceſſion, ſo that the extended part of the line may get up to windward. If this manœuvre be properly executed, it will be impoſſible for the ſhips of the weather line long to maintain their ſtations, for no veſſel cloſely attacked by two others of equal force can long reſiſt.

It is of ſome conſequence to determine whether the attempt to double ſhould be made on the van or the rear of the enemy, as on the propriety of adopting the one or the other of theſe meaſures, may in a great meaſure depend the iſſue of the battle. In the preſent caſe, it is moſt eaſy to double the van of the enemy, becauſe if they are engaged by the ſhips abreaſt of them, thoſe which are advanced ahead will be able, by making all ſail, to get in the perpendicular to the direction of the wind with the van of the enemy, and tack in ſucceſſion to gain the wind of them on the other board, thus keeping them to leeward; and when they are come ſufficiently to windward, they are again to go about, in order to keep the two headmoſt ſhips of the enemy's line continually under their fire. If there be two or three ſhips to tack in ſucceſſion and gain the wind of the enemy, they may edge down on the van of the water line at pleaſure, keeping themſelves a little to windward of it; and as that van is already engaged by the other ſhips abreaſt on the other ſide, ſhe muſt neceſſarily be ſoon diſabled. If they bear away, they muſt drop upon the line with which they are engaged to leeward, while the ſhips to windward ſtill continue to cannonade them. If they attempt going about, in order to attack more cloſely the ſhips to windward, they will be raked, while in ſtays, by their opponents to leeward and to windward, who enfilading them with whole broadſides, which they cannot return, muſt complete their diſorder. If they make ſail, in order to fruſtrate the deſign of the ſhips inclined to double, thoſe with which they are engaged abreaſt to leeward have only to perform the ſame manœuvre, and keep them under their fire; while the others, after having haraſſed them as much as poſſible, will do their beſt to perform the ſame manœuvre on the ſucceeding ſhips.

If any of the ſhips in the van of the weather line are diſabled in their maſts or yards, they will drop aſtern, and run foul of the next ſucceeding ſhip, and theſe again on the next aſtern. Thus, the enemy's order of battle will be broken, while on the other hand the lee line is preſerved; and thoſe ſhips which have gained the wind of the enemy will, without engaging more ſhips than they can manage, contribute to increaſe the confuſion.

When the enemy is to leeward, and the weather fleet attempts to double, the ſhips of the weather line muſt extend their van beyond that of the enemy, and then veer in order to bring the headmoſt ſhips of the lee line between two fires. It muſt not, however, be concealed, that it is much more dangerous to the ſhips engaged in this ſervice to attempt doubling a fleet to leeward, than one to windward, as if diſabled, or ſeparated too far from their own fleet, they cannot ſo eaſily extricate themſelves, and rejoin the fleet.

83 To avoid being doubled.

When one fleet attempts to double another, this latter will of courſe do all in their power to avoid the impending danger; and this they will the more readily do, according to their number, or their ſituation. If the fleet thus threatened be to windward, one of the methods propoſed to avoid being doubled, is to extend the line towards the point threatened, ſo as to leave a greater ſpace between the ſhips; but in doing this, there is a riſk of having the line broken by the ſuperior enemy. Another method ſuggeſted is, for the flag ſhips of the windward fleet to oppoſe themſelves to thoſe of the lee line, which is ſuppoſed to render ſeveral of the enemy's ſhips in the intervals of little uſe; but one great inconvenience of this manœuvre is, that it leaves the van and rear moſt expoſed to the enemy's fire, and that the rear diviſion in particular is in great danger of being doubled. To remedy theſe defects, the largeſt ſhips ſhould be placed in the van and rear of each diviſion, and the fleet muſt regulate its ſailing in ſuch a manner that its rear ſhall never be aſtern of the rear of the enemy.

When the enemy is to leeward, the weather fleet is to keep aſtern of the enemy, ſo that the van of the weather fleet, may be oppoſed to, and attack the enemy's centre. Hence the enemy's van will become uſeleſs for ſome time; and ſhould it attempt to tack and double on the weather fleet, much time will be loſt in performing that evolution; and it alſo runs the riſk of being ſeparated by the calm which often happens in the courſe of an engagement, occaſioned by the diſcharge of the guns. A conſiderable interval might alſo be left between the centre and van, if neceſſary precautions be taken to prevent the van from being cut off.

84 Of chaſing.

There are ſeveral circumſtances of importance to be conſidered in the ſubject of chaſing, i. e. when one ſhip or fleet purſues another, called the *chaſe*, either to bring her or them to action, or to oblige them to ſurrender.

85 In the caſe of ſingle ſhips.

When a ſingle ſhip chaſes another, it is to be preſumed in general, that one of them is the better ſailer, though this is not always the caſe, and ſtill by proper manœuvering the chaſing ſhip, or *chaſer*, may gain on the chaſe. In the following obſervations, however, we ſhall ſuppoſe the chaſer to ſail faſter than the chaſe. The manœuvres of the chaſer will depend on her being to windward or leeward of the chaſe.

When the chaſe is to windward, it is evident that as ſoon as ſhe perceives a ſtrange ſhip which ſhe takes for an enemy, ſhe will haul her wind, in order to prolong the chaſe, as otherwiſe her retreat would ſoon be cut off. The chaſer then ſtands on alſo nearly cloſe hauled, till ſhe has the chaſe on her beam; ſhe then tacks, and ſtands on cloſe hauled till the chaſe is again on her beam, and then retacks. In this manner ſhe continues tacking every time ſhe brings the chaſe perpendicular to her courſe on either board; and by thus manœuvring, it is certain that the chaſer will, by the ſuperiority only of her ſailing, join the other in the ſhorteſt time. For ſince the chaſer tacks always as ſoon as the chaſe is perpendicular to her courſe, ſhe is then at the ſhorteſt diſtance poſſible on that board; and ſince the chaſer is ſuppoſed to be the faſter ſailer, theſe ſhorteſt diſtances will decreaſe every time the chaſer tacks. It is therefore of advantage to the chaſe to keep conſtantly on the ſame courſe, without loſing her time in going about, as tacking cannot be ſo favourable to her as to her adverſary, whoſe ſailing is ſuperior. If the captain of the chaſer ſhould ſo little underſtand his profeſſion as to ſtand on a long way, and tack in the wake of the chaſe, the beſt thing ſhe can do is to heave in ſtays, and paſs to windward of him on the other tack, except ſhe ſhould find herſelf likely gaining advantage by going large; for if the chaſer perſiſts in tacking in the wake of the other ſhip, the purſuit will be very much prolonged.

When the chaſe is to leeward, the chaſer is to ſteer that courſe by which ſhe thinks ſhe will gain moſt on the chaſe. If, after having run a ſhort time, the chaſe is found to draw more aft, the chaſer ſhould then bear away a little more; but if the chaſe draw ahead, the chaſer ſhould haul up a little, and thus the courſe may be ſo regulated that the chaſe may always bear on the ſame point, and then the chaſer will get up with the chaſe in the ſhorteſt time poſſible; for if any other courſe were ſteered, the chaſer would be either too far ahead or too far aſtern, and hence the purſuit would be prolonged. The chaſe ſhould run on that courſe which will carry her directly from the chaſer, and ſhould conſider which is her beſt trim with reſpect to the wind, that ſhe may move with the greateſt poſſible rapidity from the chaſer; for ſome ſhips have more advantage in going large, others with the wind right aft, and others when cloſe hauled.

86 Curve of purſuit.

Plate DLXVIII. Fig. 11.

Another method has been propoſed for chaſing a ſhip to leeward, that is, by conſtantly ſteering directly for the chaſe: in this caſe, the tract deſcribed by the chaſer is called the line or *curve of purſuit*. To illuſtrate this, let A (fig. 11. Plate DLXVIII.) repreſent the chaſer, and B the chaſe directly to leeward of her, and running with leſs velocity than the purſuer, in the direction BC, perpendicular to that of the wind. Now, to conſtruct this curve, let B *b* be the diſtance run by the chaſe in any ſhort interval of time; join A *b* and make A 1 equal the diſtance run by the chaſer in the ſame time. Again, make *bc*, *cd*, *de*, *ef*, &c. each equal to B *b*; join 1 *c*, and make 1, 2=A 1; join 2 *d*, and make 2, 3 equal to A 1; proceed in like manner till the two diſtances carried forward meet as at C, and a curve deſcribed through the points A, 1, 2, 3, &c. will repreſent nearly the curve of purſuit; and the leſs the interval A 1 is taken, the more accurately will the curve be formed. In this particular caſe, the length of the diſtance BC may be found as follows, provided the diſtance AB and the proportional velocities of the two ſhips be known.

Let the velocity of the chaſe be denoted by a fraction, that of the chaſer being unity. Multiply the given diſtance AB by this fraction, and divide the product by the complement of the ſquare of the ſame fraction, and the quotient will be the diſtance run by the chaſe B. Suppoſe AB, the diſtance of the chaſe directly to leeward of the chaſer, be taken at 12 miles, and ſuppoſe the velocity of the chaſe three-fourths of that of the chaſer; what will be the diſtance run by the chaſe before ſhe is overtaken? Now $\frac{12\times\frac{3}{4}}{1-\frac{3}{4}|^2}=\frac{9}{\frac{7}{16}}=9\times\frac{16}{7}=20\frac{4}{7}$ miles; and ſince the velocity of the chaſer to that of the chaſe is as 4 to 3, hence the diſtance run by the chaſer will be $=20\frac{2}{7}\times\frac{3}{4}=27\frac{3}{7}$ miles. As the chaſer alters her courſe at every point, and probably ſails better with the wind in one direction with reſpect to her courſe than when the wind is in another direction, her velocity will be different at different points of the courſe. Thus, ſuppoſe her to ſail faſter when the wind is on the quarter, her velocity will conſtantly increaſe to a certain point, and will then diminiſh. Hence in real practice the curve of purſuit will not be exactly what is laid down in the above problem, and of courſe the meaſure of BC will differ a little from what we have there laid down. See *RESISTANCE of Fluids* and SEAMANSHIP.

87 In the caſe of fleets.

If the whole fleet is to give chaſe, the admiral will make the proper ſignal, and then each ſhip will inſtantly make all the ſail poſſible. If the retreating fleet is not much inferior to the other, a few of the faſteſt ſailing veſſels only are to be detached from the ſuperior fleet, in order to pick up any ſtragglers, or thoſe ſhips which may have fallen aſtern; and the remaining part of the fleet will keep in the ſame line or order of ſailing as the retreating fleet, ſo that they may, if poſſible, force them to action. But if the retreating fleet is much inferior, the admiral of the ſuperior fleet will make the ſignal for a general chaſe, and then each ſhip will immediately crowd all the ſail poſſible after the retreating fleet; or, if the chaſe be ſtill leſs numerous, the admiral will detach one of the ſquadrons of his fleet, by hoiſting the proper ſignal for that purpoſe, and he will follow with the remainder of the fleet. The ſquadron that chaſes, ſhould be very careful not to engage too far in the chaſe, for fear of being overpowered; but at the ſame time to endeavour to ſatisfy themſelves with regard to the object of their chaſe. They muſt pay great attention to the admiral's ſignals at all times; and, in order to prevent ſeparation, they ſhould collect themſelves before night, eſpecially if there be any appearance of foggy weather coming on, and endeavour to join the fleet again. The ſhips are diligently to obſerve when the admiral makes the ſignal to give over chaſe; that each regarding the admiral's ſhip as a fixed point, is to work back into her ſtation, to form the order or line again as quickly as the nature of the chaſe and the diſtance will permit.

When a fleet is obliged to run from an enemy who is in ſight, it is uſual to draw up the ſhips in that form or order, called the *order of retreat;* and the admiral, when hard purſued, without any probability of eſcaping, ought, if practicable, to run his ſhips aſhore, rather than ſuffer them to be taken afloat, and thereby give additional ſtrength to the enemy. In ſhort, nothing ſhould be neglected that may contribute to the preſervation of his fleet, or prevent any part of it from falling into the hands of the conqueror.

We have now gone through the principal evolutions of fleets and ſquadrons, nearly as they are deſcribed in the *Elements of rigging, ſeamanſhip, and naval tactics*, and other approved publications on ſimilar ſubjects. We have indeed omitted the method of forcing an enemy's line, and of avoiding being forced, becauſe the former will be readily underſtood from what we have to add on the improved method of tactics of M. Grenier, and Mr Clerk of Eldin.

88
Defects of the uſual line of battle.

Various defects have been obſerved in the tactics uſually employed at ſea, eſpecially in a line of battle, and in the mode of bringing an enemy to action. The uſual order of battle firſt introduced by the duke of York, afterwards James II. of England, is defective from its length. Its great extent makes it difficult for the admiral to judge what orders are proper to be iſſued, to the ſhips ſtationed at the extremities, while his ſignals, however diſtinctly made, are liable to be miſtaken by the commanders of theſe ſhips. Beſides, the extremities of a long line, eſpecially if it be to leeward, are neceſſarily defenceleſs, as the enemy may throw himſelf with a ſuperior force on the van or rear, and cut either of theſe off before it can be properly ſupported by the other ſquadrons. Viſcount de Grenier, who was, we believe, one of the firſt to notice theſe defects, propoſed to remedy them by introducing a new order of battle.

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Principles of de Grenier's method of tactics.
Plate DLXVIII. Fig. 12.

The leading principles of De Grenier's tactics are founded on the following conſiderations. It is evident that each ſhip of a fleet muſt at all times occupy the centre of a certain horizon. This horizon De Grenier divides into two unequal parts, calling the greater the *direct and graduated ſpace*, and the leſs the *indirect, croſſed, and ungraduated ſpaec.* The reaſon of theſe appellations is, that on the greater ſegment of the horizontal circle there are 20 different points, which may be marked by degrees from one of the cloſe-hauled lines to the other, and to which a ſhip may ſail from the centre by ſo many direct courſes without tacking; whereas from the other 12 points, including that from which the wind blows, ſhe cannot arrive but by ſteering croſs courſes, which muſt neceſſarily delay her progreſs. Suppoſe now a fleet to leeward, ſo diſpoſed that only a part of it can fight with another equally numerous, and ranged to windward in a ſingle line, and let the lee fleet be ranged on three ſides of a lozenge *a b*, *c d*, *e f*, (fig. 12.). The ſquadron *a b*, which is moſt to windward, being drawn up in line of battle, cannot be fought but by an equal number AB, CD, EF. All the reſt of that fleet therefore muſt remain inactive, unleſs the ſhips which are not engaged ſhould try to paſs to leeward of the fleet *a b*, *c d*, *e f*. But ſhould the ſhips of the weather fleet, which are placed between B and F, bear away as they appear in the figure between C *i* and F *i*, the ſhips between A and B, which are fighting to windward, cannot bear away with them. Suppoſe now that the ſhips between C *i* and F *i* have paſſed to leeward, the ſquadrons *c d*, *e f*, which are ranged according to De Grenier's ſyſtem, and have not yet been engaged, ſhould come to windward and join with their friends *a b* againſt that ſquadron of the enemy AB which is ſtill to windward and engaged; it is almoſt impoſſible but that the ſquadron AB muſt be deſtroyed by ſo great a ſuperiority, before it could receive aſſiſtance from the ſhips to leeward between C *i* and F *i*.

90
His orders of ſailing.

De Grenier propoſes only three orders of ſailing, one when a fleet is to paſs a ſtrait; a ſecond when it ſteers in open ſea, on the look out for an enemy, or with a view to avoid him; and a third when on an extenſive cruiſe diſpoſed ſo that it cannot be eaſily ſurpriſed or broken. Of theſe three orders only the ſecond and third differ from the uſual orders of ſailing. The former of theſe is repreſented by fig. 1. Plate DLXIX. where the columns *a b*, *c d*, *e f*, are diſpoſed on three ſides of a regular lozenge, on the two cloſe-hauled lines. The ſhips of the two diviſions *c d*, *e f*, ſometimes to windward (as in fig. 2.) and ſometimes to leeward (as in fig. 1.) of the third diviſion *a b*, are to be formed on two parallels of one of the cloſe-hauled lines in the wakes of their reſpective headmoſt ſhips; while the third diviſion *a b* is to be ranged ahead or aſtern of the others on the other cloſe-hauled line, ſteering chequerwiſe the ſame courſe as the other diviſions.

Plate DLXIX. Fig. 1. and 2.

When *a b* is to windward of *c d* and *e f* (fig. 1.), De Grenier calls that the *windward primitive order of ſailing*, and when to leeward (fig. 2.), the fleet is ſaid to be in the *leeward primitive order of ſailing.* Theſe are the two principal poſitions in almoſt every caſe, and with very little variety, may become the order of battle, of chaſing, &c.

Fig 3.

His third order is illuſtrated by fig. 3. where the diviſions *a b* and *e f*, are ſuppoſed at the diſtance of about ſix leagues from each other; *c d* and *e f* reſting on the extremities of the baſe of a triangle STV, while the centre ſhip of the diviſion *a b* reſts on its ſummit T; none of the diviſions could be cut off by an enemy, however formidable, ſeen from its centre ſhip at the diſtance of ſix leagues. For if, on the proper ſignal, the diviſion *a b* ſhould ſteer from T toward X, on the courſe

oppoſite

oppoſite to the cloſe-hauled line it ſteered before, and the two diviſions *c d* and *e f* ſteer from V and S towards X likewiſe, it is plain that each of theſe diviſions would have only three leagues to run to join the other two, while the enemy which was firſt perceived at the diſtance of ſix leagues, muſt run nine before he can come up with the neareſt of theſe ſquadrons.

91 His order of battle. Plate DLXIX. Figs. 4, and 5.

To form De Grenier's order of battle repreſented in fig. 4. and 5. it will be ſufficient for the ſhips of the three diviſions ranged in the windward primitive order of ſailing (ſee N° 90.) to heave in ſtays all together, and get on the other tack on the oppoſite line of bearing (fig. 4.); or for the ſhips in the leeward primitive order at once to haul the wind on the ſame tack as they ſteer; and they will find themſelves in order of battle, fig. 5. When the two columns *c d* and *e f*, are to leeward of the third diviſion *a b*, ranged in order of battle, this is called the *natural order of battle*, and when *c d* and *e f* are to windward of *a b*, this is the *inverted order of battle*. The former of theſe is calculated for a fleet combating to leeward, and the latter for a fleet which muſt fight to windward.

Fig. 6.

To explain the advantages of theſe diſpoſitions, let us ſuppoſe the line AB, CD, EF, fig. 6. to repreſent an enemy's fleet to windward in the uſual order of battle, on the cloſe-hauled line, and on the ſtarboard tack, and let *a b* be one of the diviſions of a fleet diſpoſed according to the now natural order, on the ſtarboard tack, while the line *c d*, *e f*, repreſent the other two diviſions ſtanding on chequerwiſe on the ſame tack, but formed on the oppoſite cloſe hauled line. When the enemy comes to attack this latter fleet on a ſuppoſition that it is inferior to their own, their diviſions AB and EF, in order to attack the ſhips *a* or *b*, muſt bear away. Now, to prevent the attack, each of the diviſions *c d*, *e f*, muſt make the following evolutions according to their reſpective ſituations, and the manœuvres of the enemy. 1. The ſhips of the diviſion *a b* are to ſlacken as much as poſſible their headway, and form a very cloſe line, till the enemy makes a movement to attack the headmoſt or ſternmoſt ſhip of that diviſion. 2. The ſhips of the diviſion *c d* are to make ſail till they come under the ſecond or third ſhip of the rear of the line of battle *a b*, when they will take the ſame ſail as the ſhips of that diviſion, to preſerve that poſition until the hoſtile ſhips make their evolution to attack the rear ſhips of that diviſion. In this ſituation the ſhips of the diviſion *c d* will be able to obſerve the manœuvres of the enemy, in order to change tack, and form themſelves in order of battle on the oppoſite board as ſoon as the hoſtile ſhips ſhall have run over a certain ſpace; becauſe the ſhips of the diviſion *c d*, ſteering afterwards cloſe hauled in the wake of the ſternmoſt ſhip of the diviſion *a b*, will be able to cover the rear ſhips of that diviſion, and get the weather-gage of the hoſtile diviſions which are bearing away; rake their ſhips; run along ſide of them; double their rear-guard, and put it between two fires, if thoſe hoſtile ſhips are following in the wake of each other divide it, if they bear away chequerwiſe, or gain to windward, and put between two fires the enemy's diviſion CD, while engaged with the diviſion *a b*. 3. The diviſion *e f* may abandon their poſt, and run chequerwiſe under a preſs of ſail as ſoon as the enemy falls ahead of *a b*; that if the enemy's diviſion AB attempts to fall on *e f*, or on the van of *a b*, they may, by going about, ſteer in order of battle cloſe hauled on the oppoſite line, and cover the ſhip *a*, double the hoſtile diviſion CD ahead, or divide AB which is running chequerwiſe on the oppoſite tack.

Fig. 7.

Fig. 7. marks another method of manœuvring by the diviſions *c d*, *e f*, when the enemy's ſhips are arranged in a ſingle line not well formed.

92 De Grenier's method of arranging the admiral's ſhip, frigates and tranſports. Figs. 8. and 9.

Figs. 8. and 9. illuſtrate De Grenier's method of placing the admiral's ſhip, and the frigates and tranſports attached to a fleet. A, fig. 8. is the admiral placed ahead of the fleet, at a ſhort diſtance from the headmoſt of the ſecond diviſion, and in the ſame direction of the wind as the headmoſt ſhip of the firſt diviſion; *f f* are two frigates obſerving the ſame rule and poſition with reſpect to the van ſhip of the third, and rear of the firſt diviſion. When the fleet is in order of battle, as in fig. 9. the admiral's ſhip A is in the centre of the lozenge, and two of the frigates, *f f*, on the fourth ſide of lozenge. The tranſports and ſtore-ſhips, when the fleet is in order of ſailing or convoy, occupy the ſpace circumſcribed by the lozenge, but in order of battle they are diſpoſed in a line oppoſite to that of the enemy.

We cannot enter on a more minute or ſatisfactory account of this ſyſtem; for a full expoſition of which we muſt refer to the original work entitled *L'Art de Guerre en Mer, ou Tactique Navale*, &c. par M. le Viſcompte de Grenier, or the extracts from it contained in the *Elements and Practice of Rigging and Seamanſhip*.

93 Mr Clerk's tactics.

We muſt now turn our attention to the improvements in tactics ſuggeſted by our countryman Mr Clerk;—improvements which have received the approbation of ſeveral diſtinguiſhed officers of the Britiſh navy, and to hints derived from which we are in a great meaſure indebted for ſome of the moſt ſignal victories which have heaped additional honour on the naval power of Britain.

94 Mr Clerk's objections to the uſual method of attack.

Before entering on an explanation of Mr Clerk's tactics, we muſt briefly ſtate his objections to the uſual method of bringing ſhips to action, by the weather ſhip or fleet ſteering directly down upon the enemy. By doing this, the enemy to leeward often has an opportunity of completely diſabling the ſhips making the attack, as the former can uſe all their guns on one ſide, while the latter can only uſe their bow chaſes. Suppoſe B, fig. 10. Plate DLXIX. to repreſent a ſhip of 80 guns to windward, in ſight of an enemy's ſhip of equal force F, to leeward. Now, if B bears down directly upon F, the latter, by lying to, as in fig. 11. will preſent a broadſide of 40 guns, all bearing for a conſiderable time on B, while the latter coming down headwiſe, can only bring the two light guns of her forecaſtle to bear on F, not to mention that F, by lying broadſide to, will have her maſts and rigging little expoſed to the enemy's ſhot, while B ſtanding head on, is expoſed to be raked by every ſhot from F, and in particular her rigging is in the utmoſt danger.

Plate DLXIX. Fig. 10. and 11.

95 His new method. Figs 12. and 13.

Inſtead of this objectionable mode of attack, Mr Clerk propoſes that B having the wind, ſhould run down aſtern as in the dotted line at fig. 12. till ſhe gets into the courſe of F, near her wake, or in ſuch a poſition as will bring her parallel to F's courſe, and within a proper diſtance, when ſhe can run up cloſe along ſide of F, and engage on equal terms; or, that ſhe ſhould ſhoot ahead, then veer, and run down on the weather bow of F, as in fig. 13. till ſhe can force the chaſe to bear

bear away to leeward, keeping cloſe by her, on equal terms, taking care in both caſes not to put it in the power of F to bring her broadſide to bear on her without retaliation.

96 Effects of firing at the hull or rigging. Plate DLXIX. Fig. 14.

Fig. 14. is employed by Mr Clerk to illuſtrate the different procedure of a French and Britiſh man of war in firing, the former at the rigging, and the latter at the hull of the enemy, with their effects. Let F repreſent a large ſhip deſirous of avoiding a cloſe engagement, but lying to, to receive with advantage an enemy's ſhip B, of equal force. Suppoſe that F, by firing at the rigging of B, may have carried away ſome of the principal ſtays, ſeveral of the windward ſhrouds, a fore-topmaſt, or other rigging of leſs conſequence, without having wounded a ſingle man; and ſuppoſe a ſecond ſhip conſort to F, receiving an enemy's ſhip like B, but firing only at her hull, ſo as to kill 30 or 40 men, without damaging her rigging. Now, when F and her conſort wiſh to avoid a cloſe engagement, it is evident that that ſhip B, which has loſt part of her rigging, is much more diſabled from coming to cloſe action than her conſort whoſe rigging is entire, though ſhe may have loſt a great number of her men.

97 One ſhip of a line of battle cannot be expoſed to the fire of many hoſtile ſhips at once. Fig. 15.

By the ſcheme at fig. 15. it is intended to illuſtrate the impoſſibility of one ſhip being expoſed to the fire of many ſhips at one time. Let I, H, F, H, I, repreſent five ſhips in line of battle ahead, about a cable's length, or 240 yards aſunder, and ſuppoſe the length of each ſhip to be 40 yards, ſo that the whole ſpace between the head of one ſhip and the head of that next adjacent equals 280 yards. Let the perpendicular line FK, extending from the beam of F ſix cables lengths or 1440 yards, be divided into ſix equal parts. It is evident that any ſhip ſtationed at E in the line FK, 720 yards diſtant, cannot long be expoſed to the fire of more than the centre ſhip F of this ſquadron. For if we ſuppoſe that H and K ahead and aſtern of F, can bring their broadſides to bear on E; by putting themſelves in poſitions for that purpoſe, they will not only diſorder their own line, but one will leave her head and the other her ſtern expoſed to a raking fire from the oppoſite ſhips BB in the enemy's line. If B can ſuffer little from the two ſhips H, H, at the diſtance of 720 yards, it is evident that ſhe will ſuffer ſtill leſs from theſe ſhips as ſhe approaches nearer the enemy's line. Again, if inſtead of a cable's length aſunder, we ſuppoſe the ſhips I, F, I, two cables length aſunder, to bear on the ſhip B. It is evident from the figure that in this caſe B will not be more expoſed to the fire of I and I at the diſtance of 1440 yards than ſhe was to that of H and H at half that diſtance; and ſo in ſimilar caſes.

98 Principles on which the bringing of ſhips to action is founded. Fig. 17.

In explaining the principles on which we are to judge of the advantages or defects of different modes of bringing ſhips to action, Mr Clerk ſuppoſes a fleet of 10, 20 or more ſhips of 80 guns each, drawn up in line of battle to leeward, as at F, fig. 16. and lying to with an intention to avoid an action; while another fleet, as B, of equal number and force, alſo drawn up in line of battle, three or four miles to windward, wiſhes to make an attack, and come to cloſe quarters on equal terms. The fleets being thus diſpoſed, ſhould the fleet at B attempt running down to attack the fleet at F, each ſhip ſtanding head on to the oppoſite ſhip in the leeward line, it is to be expected, from what we have already ſtated, that the attacking ſhips will be diſabled, at leaſt in their rigging, before they can come to cloſe action; but ſuppoſe that the commander of the weather fleet, though his ſhips have been diſabled in their rigging during their courſe *a a a* to leeward, fig. 17. has made them bring to at a great diſtance, but ſufficiently near to injure F. This latter fleet, which has been endeavouring to avoid an action, will now bear away with little injury to a new ſtation, as G, and there remain out of the reach of B's ſhot, and this fleet muſt repair its rigging before it can make another attack.

Fig. 17.

Fig. 18. Again, ſuppoſe that the fleet B, inſtead of ſtanding head on, were to run down in an angular courſe, as at fig. 18. It is plain that if any ſhip in this angular line ſhould be crippled, her defect in ſailing will occaſion a confuſion of ſeveral of the other ſhips in that line. It may be ſaid that the ſtoppage of one ſhip a-head will not neceſſarily produce a ſtoppage of every ſhip a-ſtern of her, becauſe they may run to leeward of the diſabled ſhip; but we muſt obſerve that by this time the ſhips a-head in the van A may be engaged, and conſequently not having much head way, are nearly ſtationary, ſo that each ſhip a-ſtern, in attempting to bear down as at D, D, muſt be confined to a certain courſe, and muſt run the riſk of being raked in coming down before the wind, and conſequently of being diſabled before coming up with the enemy.

Fig. 19. Thirdly, the van of the fleet B having attained their ſtation at A, a-breaſt of the van of F, fig. 19. and having begun the action, the van ſhips of F, with a view to retreat, may throw in a broadſide on the van of B, and then bear away in ſucceſſion, as at H, followed by the reſt of the fleet F, which, after exchanging broadſides with the van of B, may draw up in a new line two or three miles to leeward at I I, fig. 20.

Plate DLXX. Fig. 1. Suppoſe again, for further illuſtration, that B, fig. 1. Plate DLXX. repreſents a fleet putting before the wind, each ſhip intending, when brought to at a determined diſtance at A, to take up her particular antagoniſts in the line of the enemy F to leeward; and let F be ſuppoſed at reſt, without any motion a-head. It is eaſy to conceive that while the alternate ſhips of F's line, under cover of the ſmoke, withdraw from battle to GGG, the intermediate ſhips left behind them in the line will be ſufficient to amuſe even the whole of B's fleet, till the ſhips G ſhall form a new line HH as a ſupport from the leeward. In ſuch caſe B, after being diſabled, and not having foreſeen the manœuvre, will neither be able to prevent the intermediate ſhips with which he is engaged from bearing away to join their friends, nor, were he able, would it he adviſable to follow them, for the ſame manœuvre with equal ſucceſs can again and again be repeated.

Fig. 2. To explain the relative motion of theſe two fleets, let F, fig. 2. repreſent a fleet of 12 ſhips in line of battle, a cable's length aſunder, and ſuppoſe the length of each ſhip from the end of the jib-boom to the ſtern to be $36\frac{2}{3}$ fathoms. The whole fleet will occupy a ſpace of two Engliſh miles; and if it be ſuppoſed to ſail in the direction FG, at the rate of four knots an hour, it will in an hour have moved to G, four miles from its former poſition.

Now, let there be an oppoſite fleet B, alſo 12 ſhips, ſituated four miles to windward, and let the point A be a quarter of a mile right to windward of the point G. Then, if B by bearing away in the direction BA, gain the

the point A at the ſame time that the leeward fleet F has arrived at G, B will have moved nearly at the rate of 5½ miles an hour, and the angle contained between the direction of its line of bearing and its preſent courſe will be nearly four points.

Secondly, in fig. 3. if F, by carrying more ſail, move at the rate of ſix miles an hour, from F to G, then B, with a more ſlanting courſe, will have more difficulty in keeping the line a-breaſt while coming down to the attack, owing to the additional obſtruction which will attend each ſucceeding ſhip in ſuch a ſlanting courſe. Again, if the leeward fleet ſhall lie up one point higher, as FG, fig. 4. the rears of the two fleets will be removed to a much greater diſtance, and the van A muſt be ſooner up with the enemy's van, and of courſe ſo much farther from ſupport, while F bringing up his ſhips in ſucceſſion, may diſable the van of A, and afterwards bear away at pleaſure with little injury, as at H. Now B being ſuppoſed diſabled, and having his rear D diſtracted, will be unable to prevent F from eſcaping.

From theſe conſiderations it appears that a fleet to windward, by extending its line of battle with a view to ſtop and attack the whole line of an enemy's fleet to leeward, muſt labour under conſiderable diſadvantages, and will ſcarcely ſucceed in the attempt.

99
New mode of attack from the windward.

On theſe principles Mr Clerk explains the reaſon why, before the commencement of the preſent conteſt between Britain and France, the French fleets ſo repeatedly eſcaped from the Britiſh, without any ſerious defeat or loſs, viz. by avoiding a general engagement, and diſabling the Britiſh van as it bore down to attack them. He therefore recommends a different mode of attack from the windward, which we ſhall proceed to illuſtrate by proper diagrams.

Fig. 5.

Let F (fig. 5.) repreſent a fleet in line of battle, under eaſy ſail, willing to avoid an action, but ready to receive an attack in the uſual way, from another fleet B, three or four miles to windward, arranged in three columns. How ſhall B make the attack on F, ſo as, without aiming at the improbable advantage of taking or deſtroying the greater part of this fleet, they may ſecure three or four of the ſternmoſt ſhips? Mr Clerk adviſes, that a ſufficient ſtrength be detached to ſecure theſe ſhips, while the admiral keeps aloof with the reſt of his fleet, diſpoſed as in the figure, ready to make the neceſſary obſervations and give the requiſite ſupport to the detached ſhips. If F continues to avoid an action by ſtanding on in line, the detachment, coming into the poſition BA, will ſecure the three ſhips at I; and if the headmoſt ſhips of F were to tack, and be followed by the reſt in ſucceſſion as at fig. 6. not only the three ſhips at I will be left at the mercy of the ſhips detached from B, but two more, as G, will be expoſed to an attack from another ſquadron of B at C. If all the ſhips of F tack together, as in fig. 7. the delay, and probably the confuſion, conſequent on this manœuvre, will ſtill more endanger the ſternmoſt ſhips, or will bring on a general and cloſe action. Again, if F attempts to haul off, beginning with his ſternmoſt ſhip G, and then runs to leeward, as at fig. 8. he will expoſe his ſhips to a raking fire from B, and ſtill endanger his ſternmoſt ſhips by getting too far to leeward for their ſupport; or if the headmoſt ſhips at H, fig. 9. veer firſt, to be followed by the reſt aſtern, the danger would be ſtill greater. Thus it appears that in every aſſignable caſe, a fleet to leeward, avoiding an attack from an equal or ſuperior windward, as here adviſed, by preſerving the line, will riſk the loſs of three or more of their ſternmoſt ſhips.

Fig. 6.
Fig. 7.
Fig. 8. and 9.

Fig. 10, 11, 12.

Now, let us ſuppoſe that F, while ſtanding on in line on the larboard tack, when threatened with an attack on his rear from B, veers and paſſes on oppoſite tacks to leeward (ſee fig. 10.). The conſequence of this will be, that his headmoſt ſhips will be forced to leeward by B, and compelled to engage under diſadvantageous circumſtances, and the diſadvantage to F will be much the ſame, whether he again veers and reſumes his former poſition, as at G, fig. 11. or ſtands on before the wind, as at P, fig. 12.

Fig. 13.

We have hitherto ſuppoſed that the wind has been fixed in one point; but let us ſuppoſe it to ſhift, and let us inquire what will be the effect of ſuch a circumſtance on the two lines F and B. While the fleets are in the former poſition, F in line, and B in four diviſions B, B, B, A, ſteering E, with the wind at N, fig. 13. let the wind ſhift to the weſt. The only conſequence of this will be, that F will be thrown ſtill farther to leeward, to its greater diſadvantage. But let the wind ſhift to E, ſo as to be a-head, as in figs. 14. and 15. Still if the admiral of B manages properly, and carefully watches the motions of F, this change will produce no advantage to the latter. For B has nothing to do but veer as the wind comes round, ſo as to bring his ſhips to windward of the three ſternmoſt ſhips of F, and to leeward of the reſt of his line, ſo as to cut off the three ſternmoſt ſhips.

Figs. 14, and 15.

If the wind ſhould be ſuppoſed to veer from point to point all round the compaſs, ſo that the fleet F, maintaining the weather-gage of B, ſhall make a circuit round B to leeward; ſtill if B act cautiouſly, F will loſe the three threatened ſhips.

Fig. 16.

Laſtly, ſuppoſe the wind ſhould inſtantly ſhift to a point oppoſite to what it was at the commencement of the attack, as from N. to S. Before it can be aſcertained whether ſuch a change will be to the advantage or diſadvantage of F, the relative ſituations of the two fleets muſt be conſidered. Suppoſe that the van and centre be ſeparated at ſome diſtance from his rear, and that in conſequence this fleet ſhall have taken ſuch a poſition as is ſhown at fig. 16. Though in this caſe he will have got to windward, his three ſhips can never be regained or preſerved from the attack of B. The moſt favourable ſituation for F would be when the fleets were in the poſition denoted by fig. 13. as then he could not only ſupport his three ſhips with advantage, but even threaten, and cut off a part of B's detachment. In attempting this, however, he incurs the riſk of coming to a cloſe engagement, which we have ſuppoſed him to be ſeduloully avoiding.

Fig. 16.

100
From the leeward.

Beſides this method of attack from the windward by detachments from the main fleet, Mr Clerk ſhows how a ſucceſsful attack may be made by a fleet *to leeward*, by its breaking the enemy's line, and this either near the rear, near the centre, or not far from the van, of which caſes the two former will be moſt likely to prove ſucceſsful. The enemy's line can be cut only when the two hoſtile fleets veer on oppoſite tacks. The moſt ſimple method of effecting this is for the van ſhip of the attacking ſquadron, inſtead of ranging parallel to that of the enemy, and to leeward of him, to paſs through the firſt interval that offers, followed by the reſt of the line, which is thus led acroſs that of the enemy. In conſequence of this manœuvre, the van of the leeward fleet will be to windward of the enemy's rear, and thus the attacking ſquadron will have its line entire, while that of its adverſary is divided. Again, the ſhips of the rear diviſion, having their progreſs obſtructed, will probably crowd on each other, get into confuſion, and be driven to leeward. We cannot detail the different caſes mentioned by Mr Clerk; but for theſe and many other valuable ſuggeſtions on the ſubject of naval tactics, we muſt refer to his uſeful and ingenious Eſſay *.

The above is a very faint and meagre outline of Mr Clerk's tactics, but it is all which our limits enable us to give. It will afford general readers ſome idea of the nature of the propoſed improvements, and profeſſional men will naturally conſult the original *eſſay*.

On theſe or ſimilar principles is founded the method of *breaking through the enemy's line*, and thus cutting off a part of his fleet, ſo ſucceſsfully adopted by the Britiſh admirals in the great naval actions that have diſtinguiſhed the late and preſent wars with France. We cannot better illuſtrate the principles above laid down, than by giving a ſhort detail of the laſt of theſe memorable engagements, the BATTLE OF TRAFALGAR. With this we ſhall conclude our ſketch of *naval tactics*, and our practical obſervations on the art of WAR.

101
Battle of Trafalgar, October 21ſt, 1805.

After having been long blocked up in the harbour of Cadiz, the combined French and Spaniſh fleet effected their eſcape, while the Britiſh fleet, under the command of Lord Nelſon, was at a conſiderable diſtance. On the 19th of October 1805, the ſhips which had been left to watch the motions of the enemy, communicated to the commander in chief the agreeable intelligence, that the combined fleet had put to ſea, and was ſailing with light winds in a weſterly direction. Lord Nelſon concluding that their deſtination muſt be the Mediterranean, immediately made all ſail with his ſhips for the entrance of the ſtraits. Here he was informed by Captain Blackwood, that the enemy had not yet paſſed the ſtraits.

On the 21ſt of October, at daylight, Cape Trafalgar bearing eaſt by ſouth about ſeven leagues diſtant, the combined fleet was diſcovered about ſix or ſeven miles to the eaſtward. The wind was about weſt, and very light. As Lord Nelſon had long expected to fall in with the enemy's fleet, he had concerted with his officers the beſt and moſt expeditious meaſures for bringing them to a ſpeedy and deciſive action. As ſoon, therefore, as they hove in ſight, he immediately made the ſignal for the Britiſh fleet to bear up in two columns, as they formed in order of ſailing. The combined fleet was drawn up in line of battle, with their heads to the northward, and had formed the line with great cloſeneſs and correctneſs. It conſiſted of 33 ſhips of the line, 18 French, and 15 Spaniſh, under Admiral Villeneuve, as commander in chief, who occupied the centre in the Bucentaure, while the Spaniſh admiral, Gravina, led the rear in the Prince of Aſturias. The Britiſh fleet conſiſted of 27 ſhips, including three ſixty-fours. Lord Nelſon headed the van in the Victory, having under him the Temeraire, Neptune, Conqueror, Leviathan, Ajax, Orion, Agamemnon, Minotaur, Spartiate, Britannia, Africa, with the Euryalus, Sirius, Phœbe, and Naiad frigates, Pickle ſchooner, and Entreprenante cutter; while the rear, conſiſting of the Royal Sovereign, Mars, Belleiſle, Tonnant, Bellerophon, Coloſſus, Achille, Polyphemus, Revenge, Swiftſure, Defence, Thunderer, Defiance, Prince, and Dreadnought, was led by Vice-admiral Collingwood in the Royal Sovereign.

As the mode of attack adopted by the Britiſh was unuſual, the combined fleet was obliged to draw up their line in a new manner. It formed a creſcent, with its convexity to leeward, ſo that in leading down to their centre, the rear diviſion of the Britiſh had both their van and rear abaft the beam. Before the action commenced, every alternate ſhip was about a cable's length to windward of her ſecond ahead and aſtern, thus forming a kind of double line, and appearing, when on their beam, to leave a ſmall interval between them without crowding their ſhips. The French and Spaniards were not formed in ſeparate diviſions, but intermixed without any apparent regard to order of national ſquadrons. As the Britiſh commander had previouſly communicated to his flag-officers and captains his pre-concerted mode of attack, few ſignals were neceſſary, and none were made on approaching the enemy, except to direct cloſe order as the lines bore down.

The action commenced at noon, by the leading ſhips of both columns, breaking through the enemy's line, the Victory about the tenth ſhip from the van, and the Royal Sovereign about the twelfth from the rear; the ſucceeding ſhips breaking through in every part aſtern of their leaders, and engaging the enemy at the very muzzles of their guns. By this manœuvre the van of the enemy was unengaged, and thus the inferiority of the Britiſh, in point of number, was of leſs conſequence, while the ſuperior ſkill and bravery of Britiſh ſeamen ſoon acquired a decided advantage. The conflict was ſevere, as the enemy's ſhips were fought with a gallantry highly honourable to their commanders. The Britiſh attack, however, was irreſiſtible. About three P. M. many of the enemy's ſhips had ſtruck their colours, and their line had given way. Ten ſhips of the line, and the frigates, under Admiral Gravina, made their eſcape, and ſtood to leeward towards Cadiz. The five headmoſt ſhips of their van tacked, and, ſtanding to the ſouthward, to windward of the Britiſh line, were brought to action, and the ſternmoſt of them taken. Nineteen ſhips of the line, with three flag-officers, including the commander in chief, remained in the hands of the Britiſh. Never was there a victory more glorious or more deciſive; never was the pre-eminence of the Britiſh flag more triumphantly conſpicuous.

The events ſubſequent to this memorable battle, and the loſſes ſuſtained on either ſide, having little connection with the ſubject of the preſent article, need not be here detailed. They are freſh in the memory of our readers, and Britain ſtill laments the loſs of her immortal Nelſon *.

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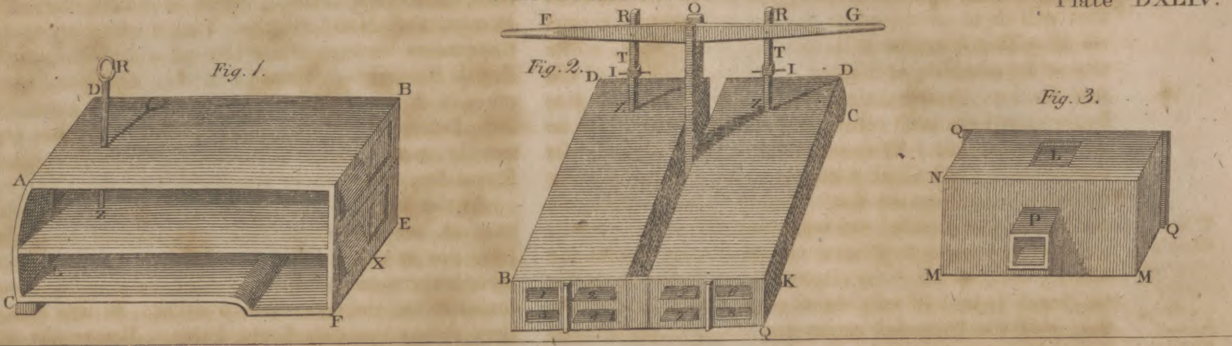
* See *Clerk's Eſſay on Naval Tactics*, ſecond Edition.

* See *Nelſon.*

Plate DXLIV

VENTILATOR.



WAR.

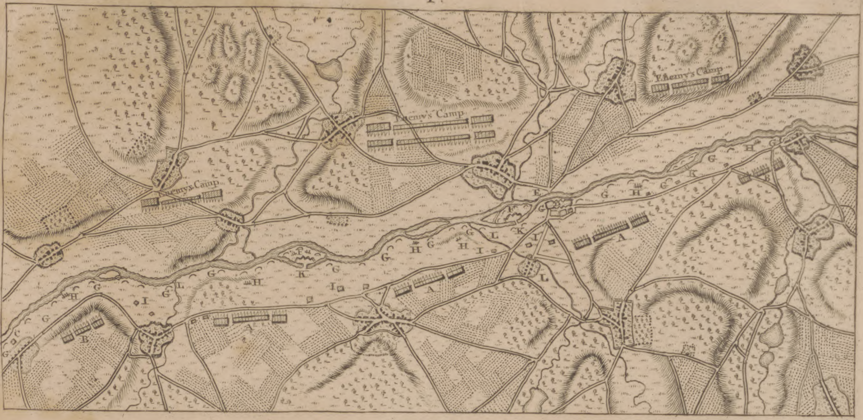
W. Archibald sculp.

WAR

Plate DXLV.

PLAN of the Position of an Army for the Defence of a RIVER.

I.



Scale of 1 League.

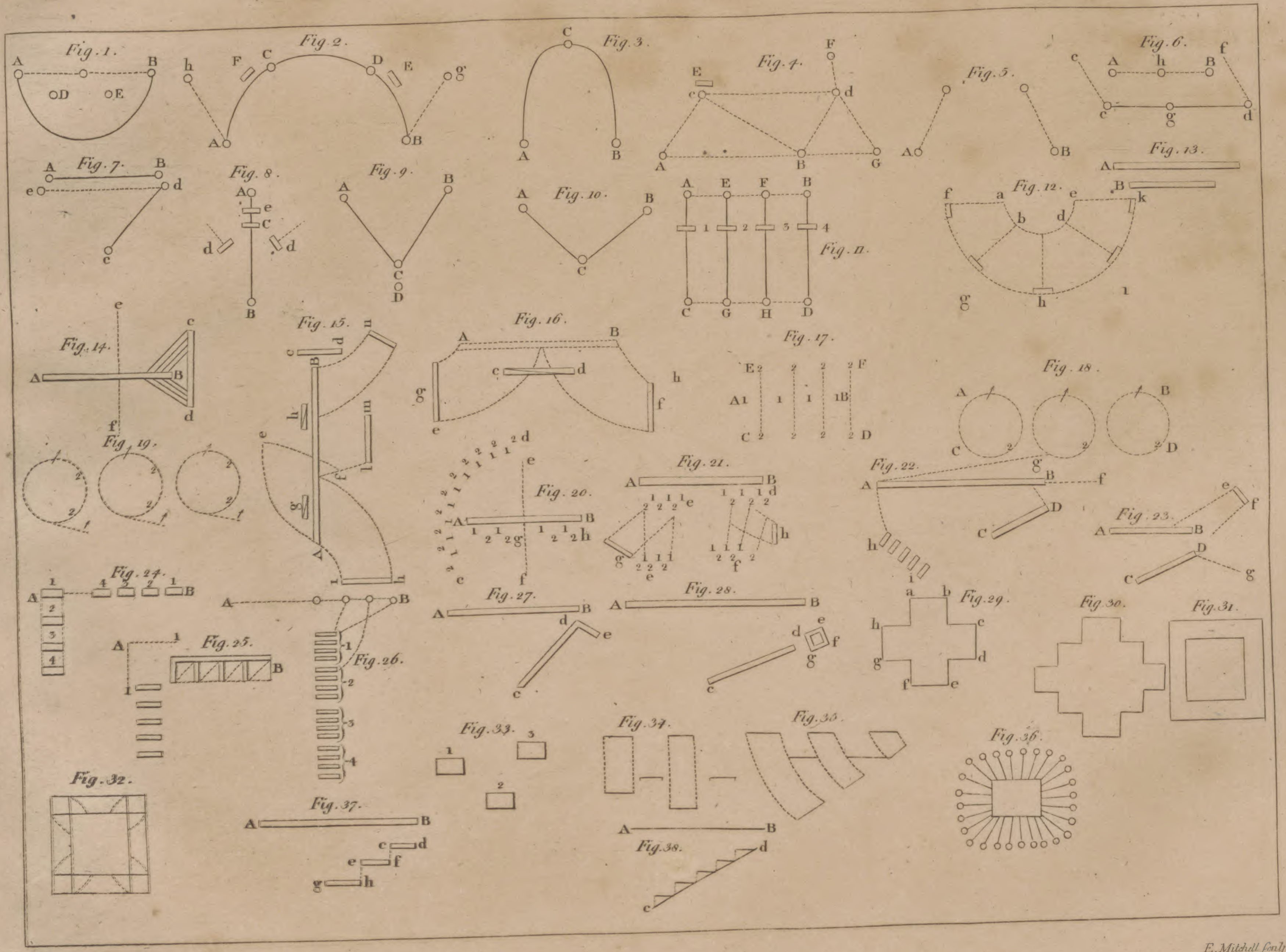
PLAN of the Passage of a RIVER.

II.

Scale of ½ a League

[illegible] Sculp.

WAR

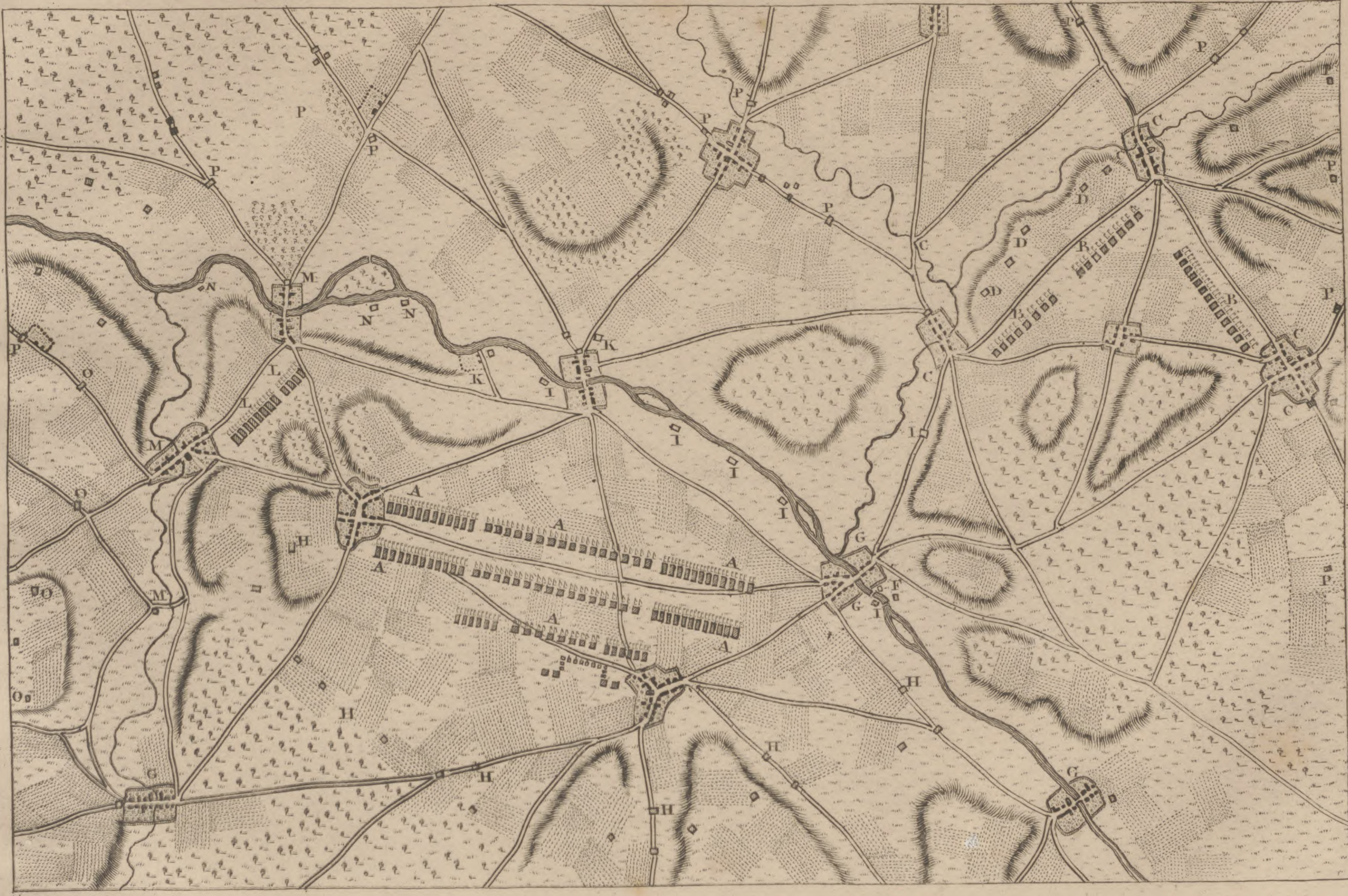


E. Mitchell sculp.^t

WAR

Plan of the Position of an Army in its Camp.

Plate DXLVII.



WAR

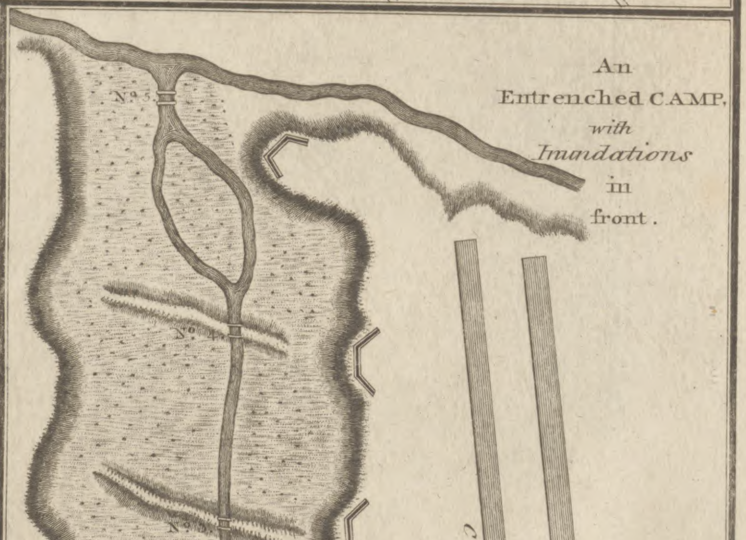
Plan of an Intrenched Camp

Fig. 1.

An *Entrenched* ARMY, *in the* Neighbourhood *of a* TOWN.

Fig. 2.

Fig. 3.



An Entrenched CAMP, *with* *Inundations* in front.

W. Train Sculp.t

WAR. Plate DL.

Fig. 1.

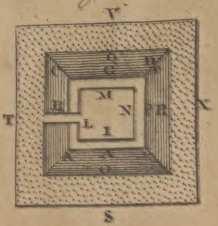


Fig. 2.

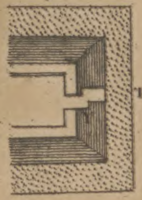
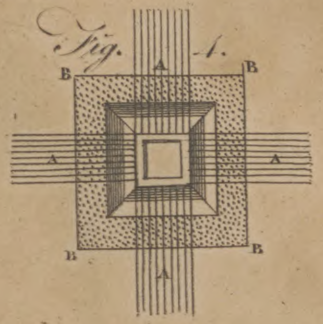


Fig. 4.



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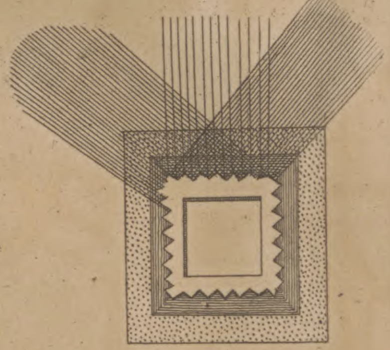
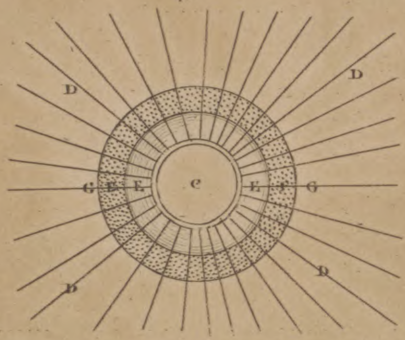


Fig. 3.

Fig. 6.



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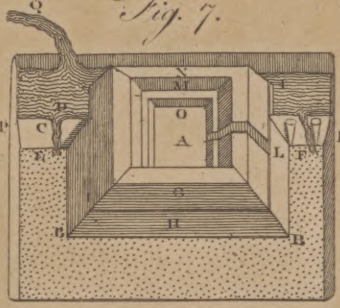
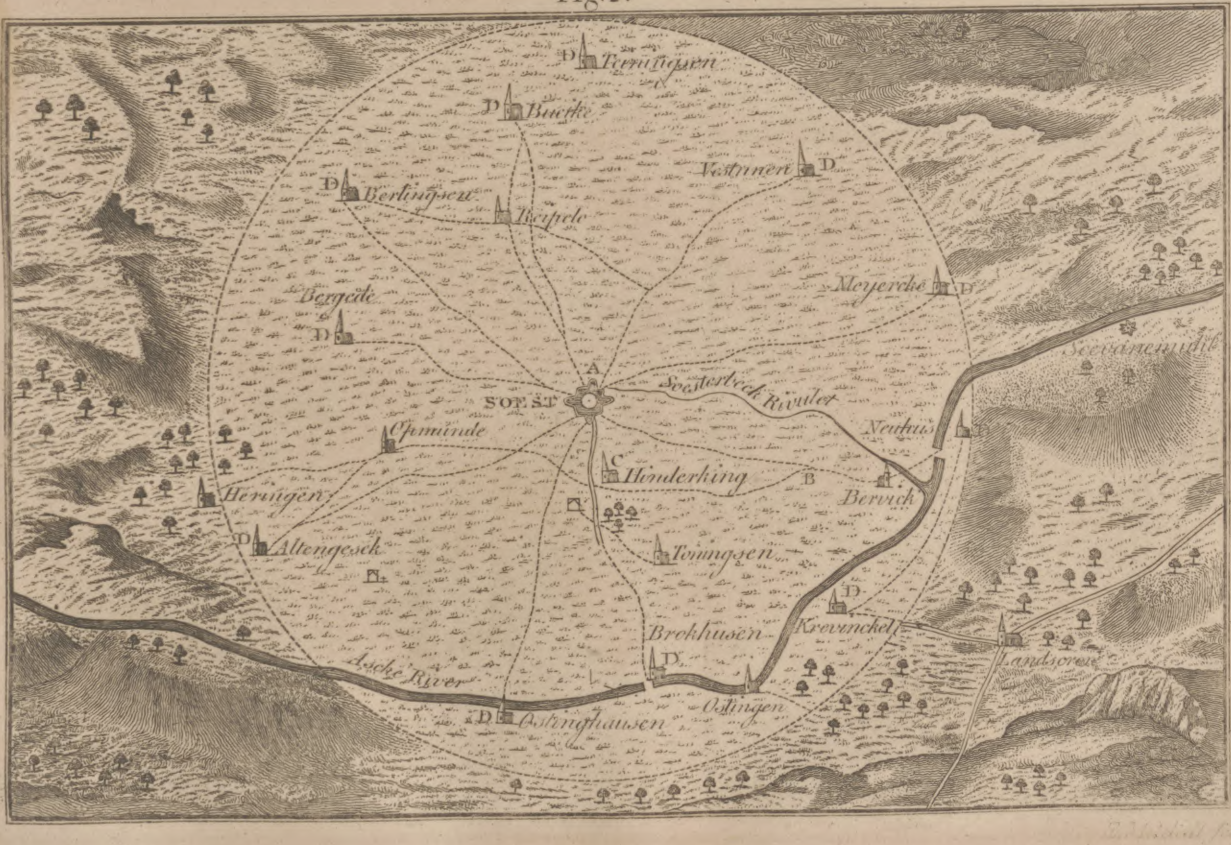


Fig. 8.

Fig. 1.

Fig. 2.



[illegible] Sculp.

Fig. 1.

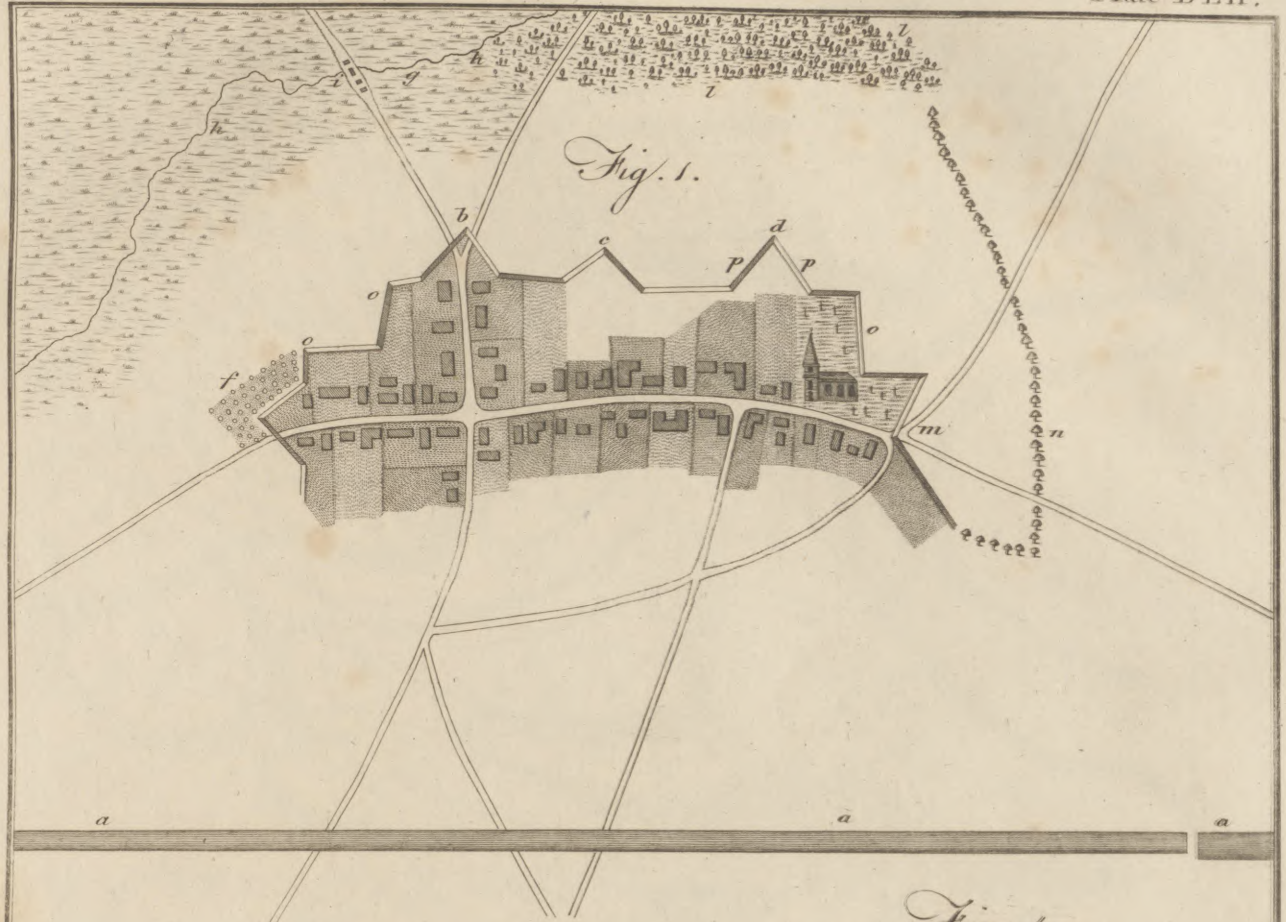


Fig. 2.

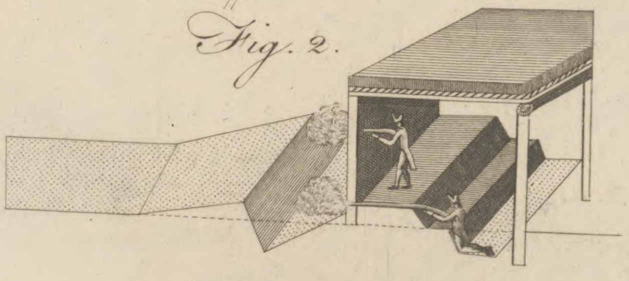


Fig. 3.

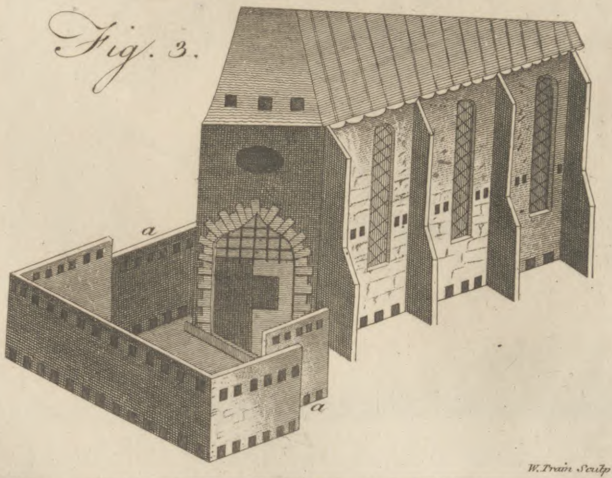
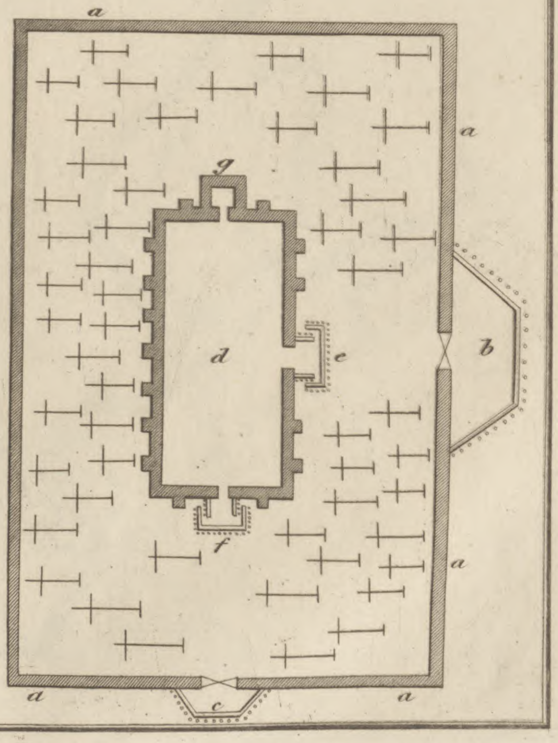


Fig. 4.



W. Frain Sculp.t

WAR. Plate DLIII

Fig. 1.

Fig. 2.

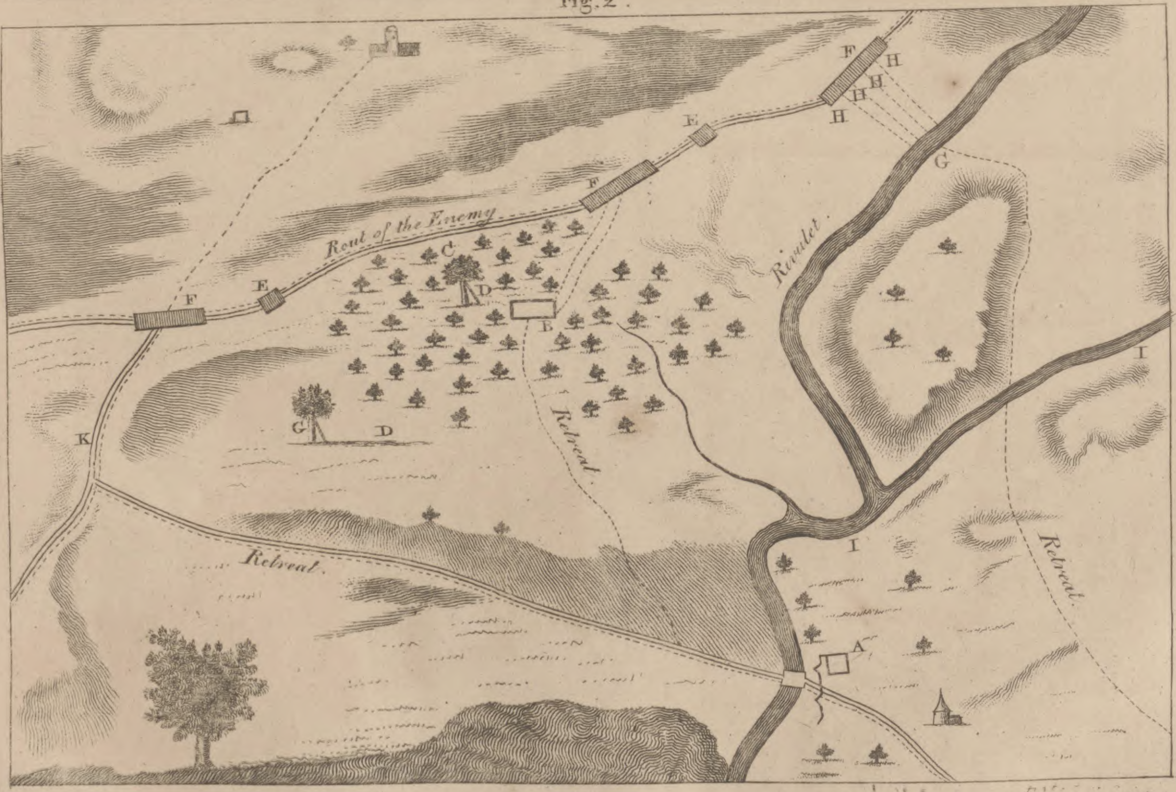
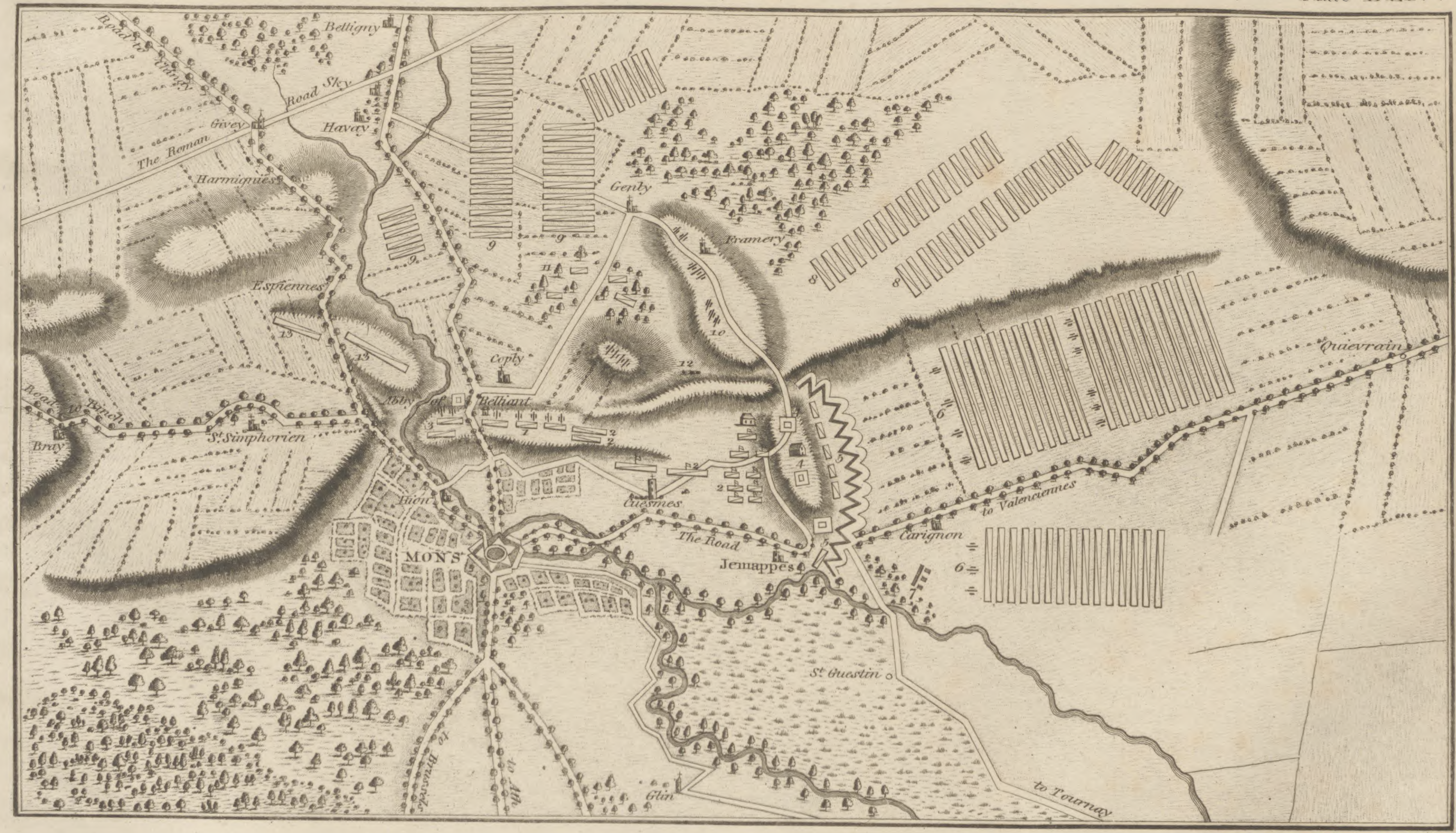


Plate DLIV.



W. Train Sculp.t

Fig. 1.

Fig. 2.

Fig. 4.

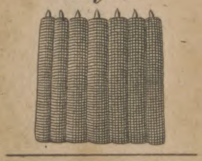


Fig. 3.

Fig. 6.

Fig. 5.

Fig. 7.

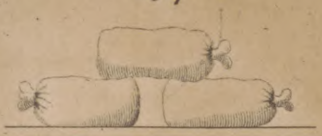


Fig. 9.

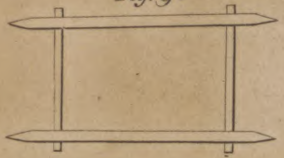


Fig. 11.

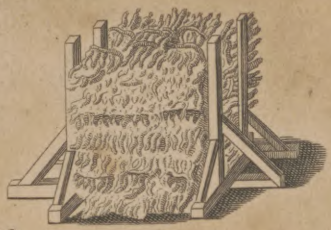


Fig. 10.

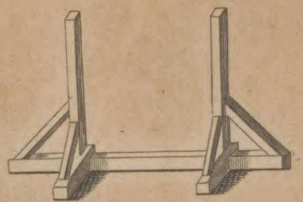
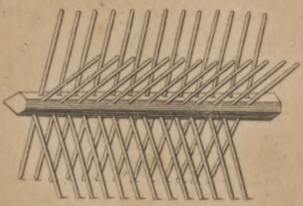


Fig. 8.

Fig. 12.



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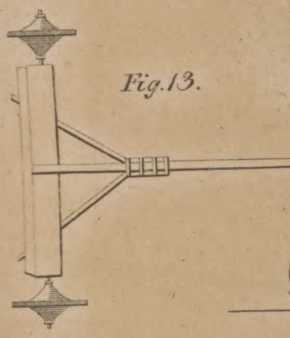
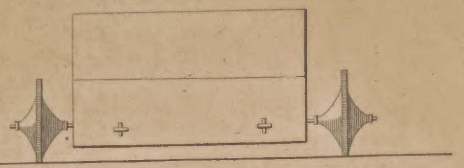


Fig. 14.

Fig. 15.



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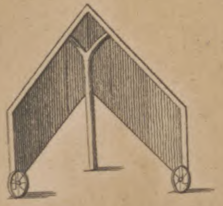

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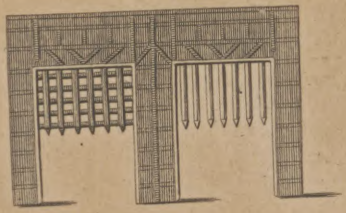

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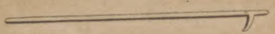

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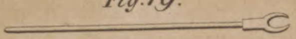

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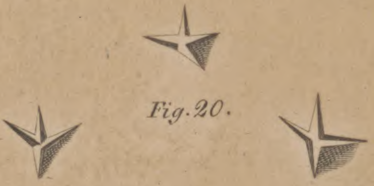

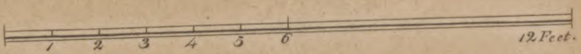

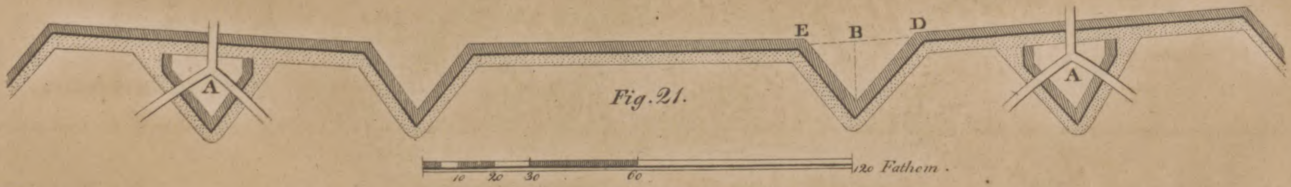

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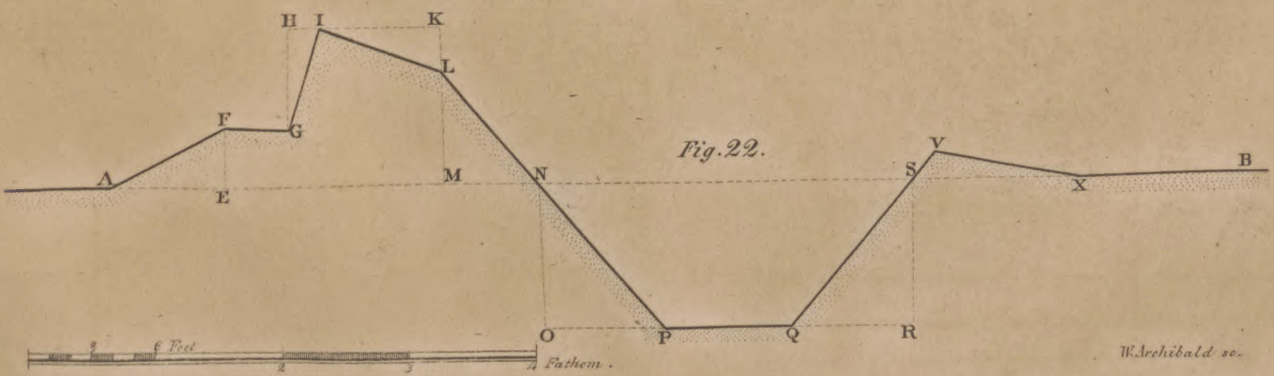


Fig. 22.

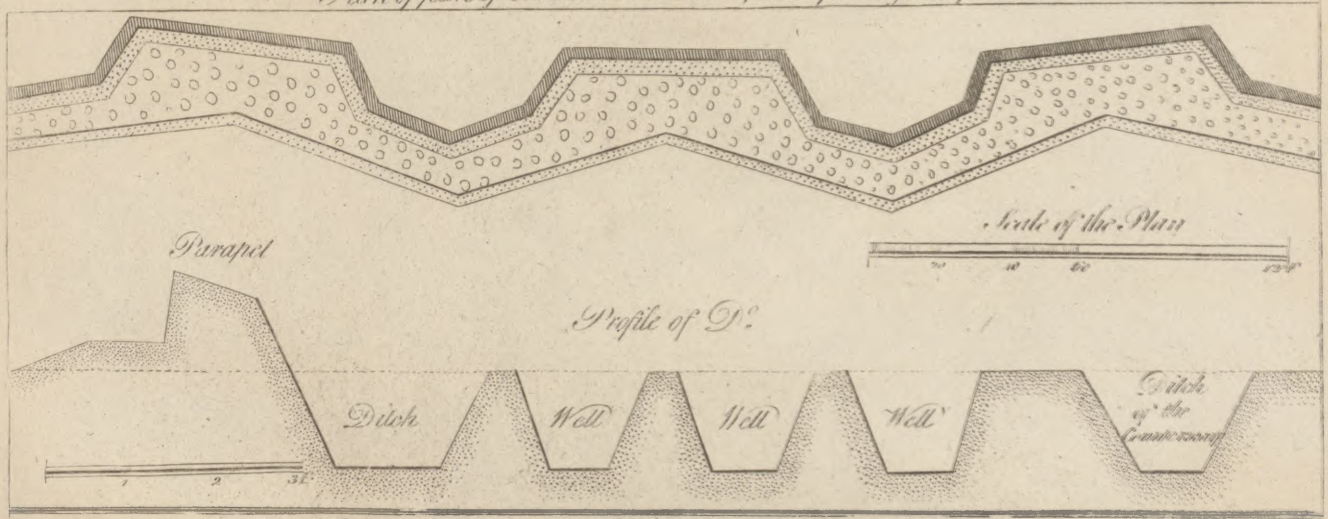
W. Archibald sc.

WAR.

Plan of the Circumvallation and Attacks of PHILIPSBURG in 1734.

Plate DLVI.

Plan of part of the circumvallation of Philipsburg in 1734.



Plan of part of a Line of circumvallation of Arras in 1654.

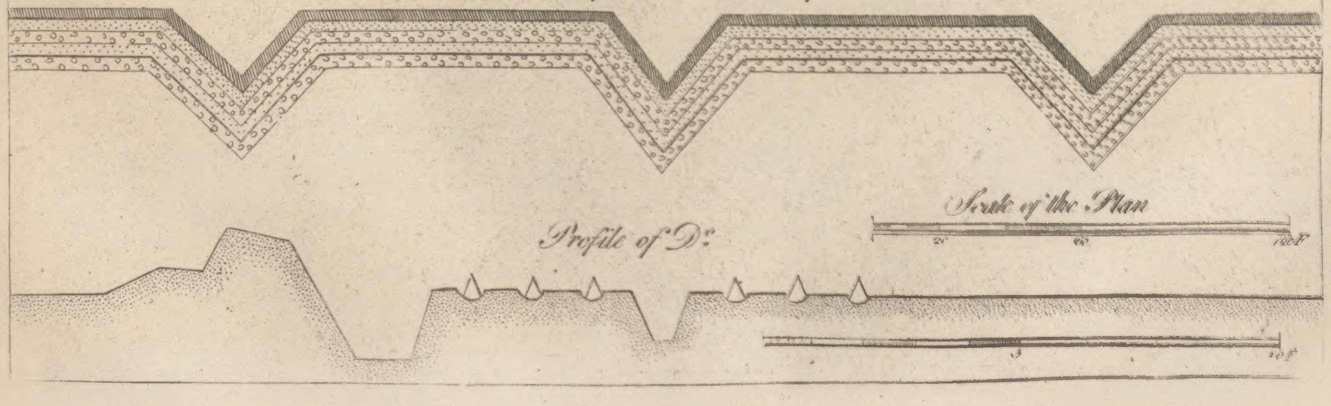
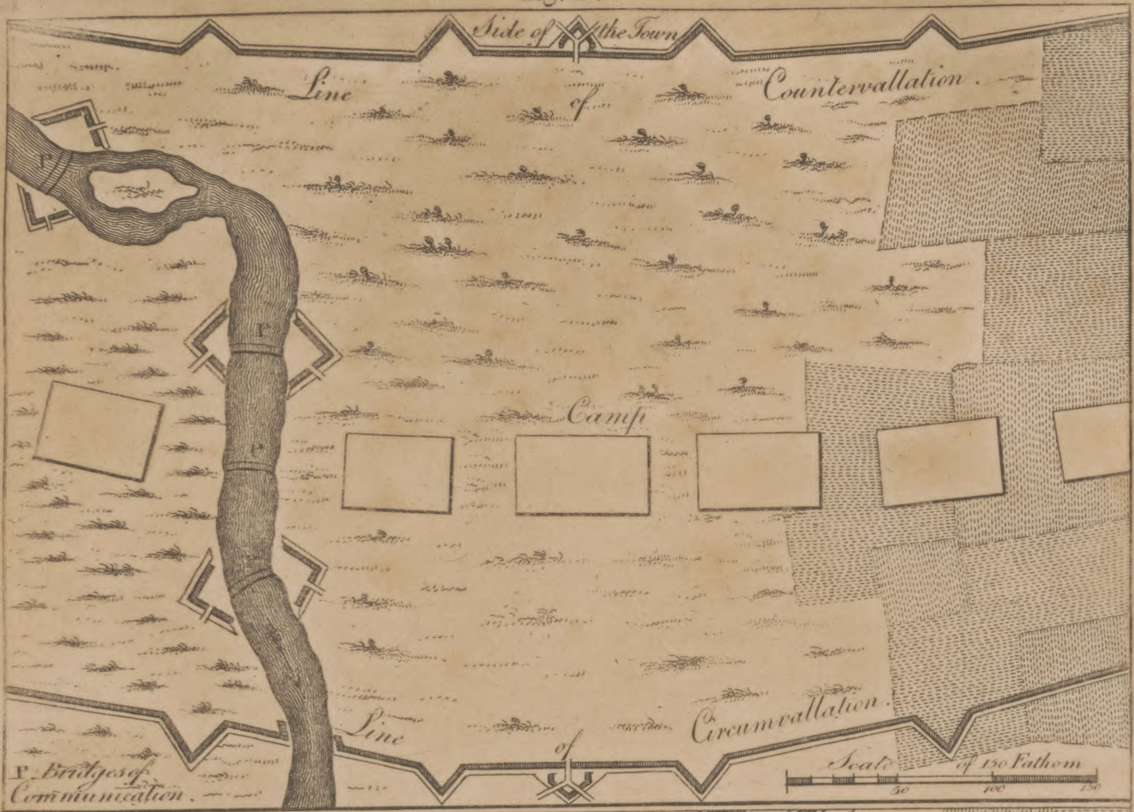
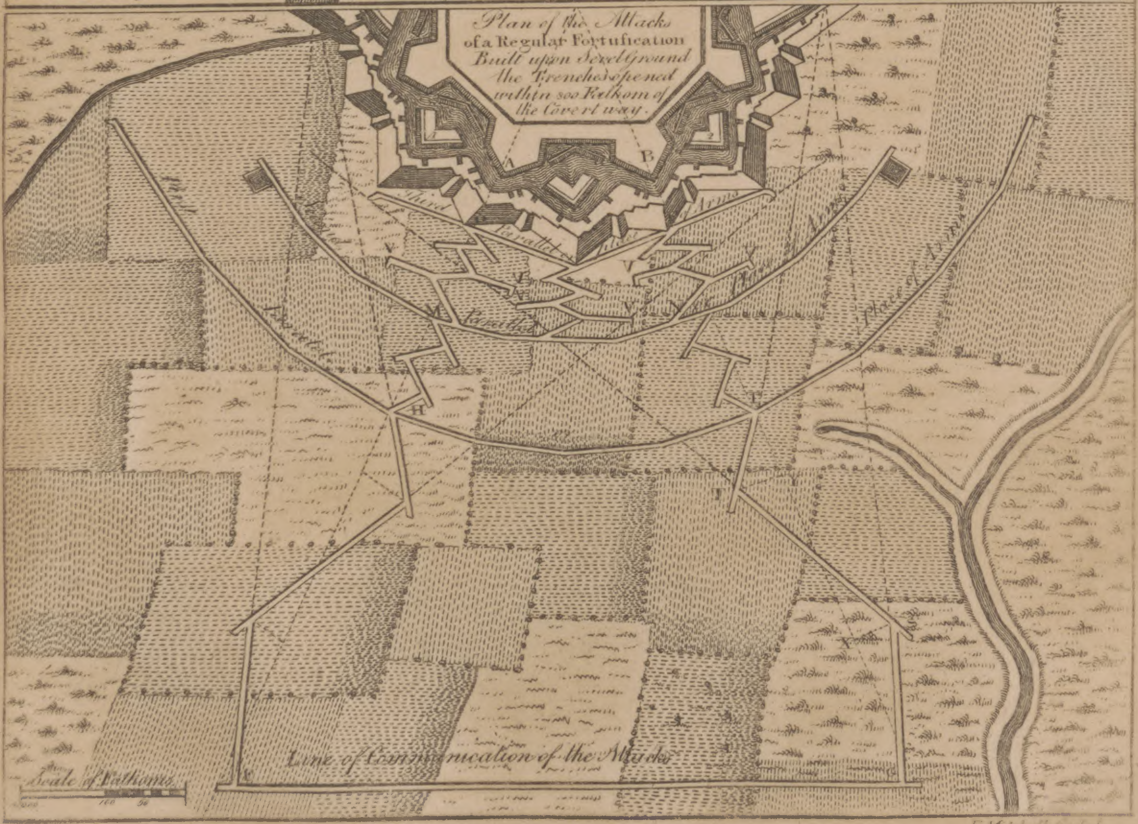


Fig. 1.





E. Mitchell sculpt.

WAR.

Attack of Fortified Places.

Plate DLVIII.

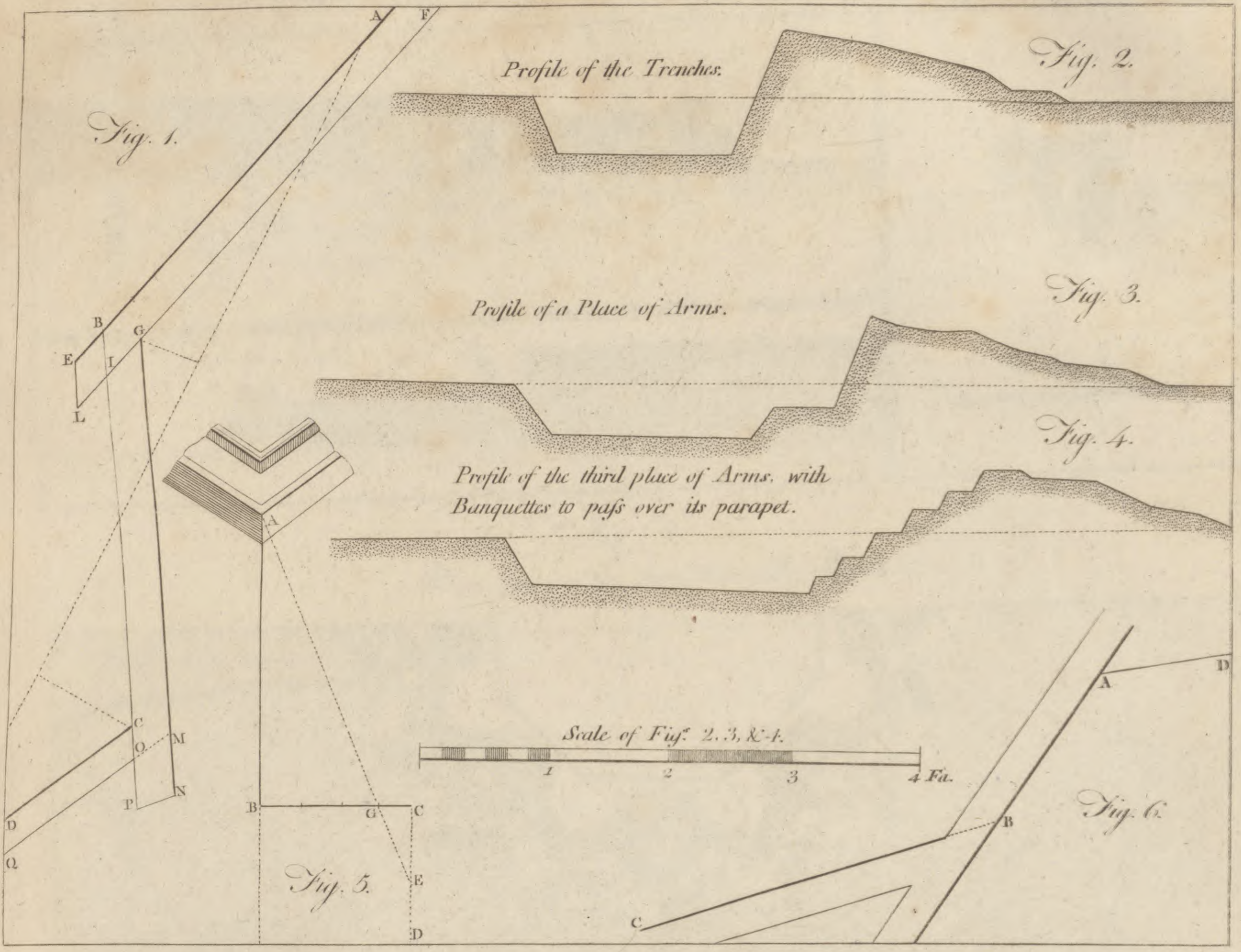


Fig. 1.

Fig. 2. Profile of the Trenches.

Fig. 3. Profile of a Place of Arms.

Fig. 4. Profile of the third place of Arms, with Banquettes to paſs over its parapet.

Scale of Figs. 2, 3, & 4.

Fig. 5.

Fig. 6.

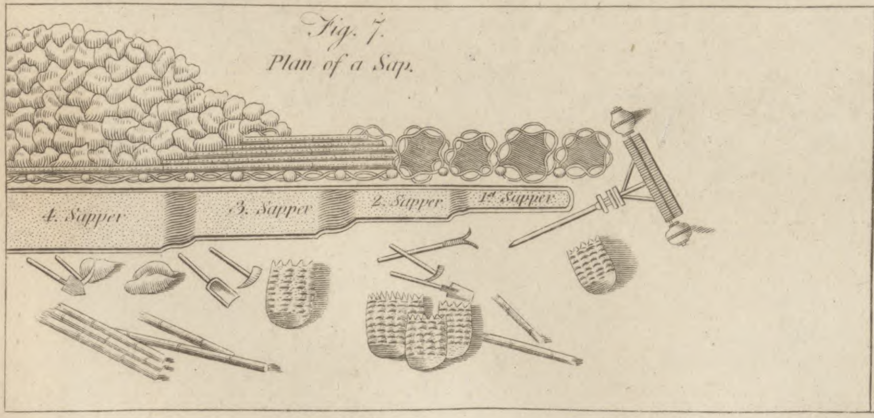


Fig. 7. Plan of a Sap.

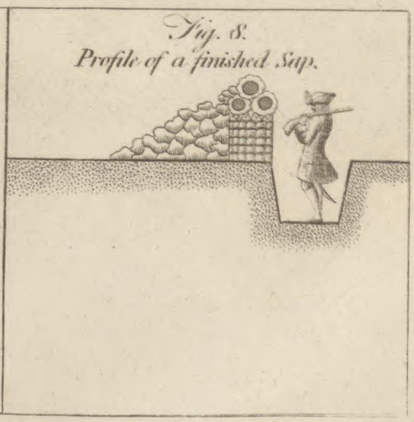


Fig. 8. Profile of a finished Sap.

Fig. 1.
Back of a Sap.

Front of a Sap.

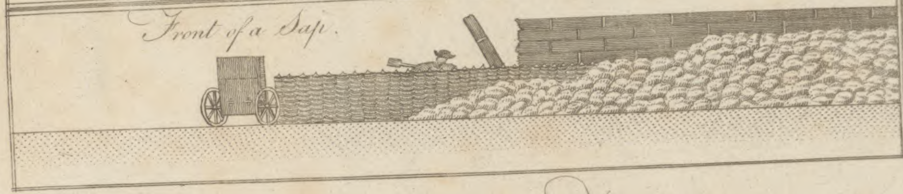


Fig. 2.
Profile representing the excavation of 4 Sappers.

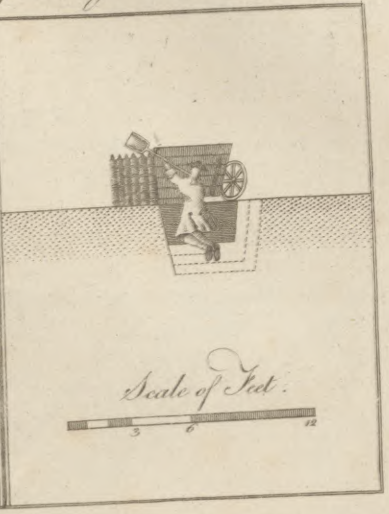
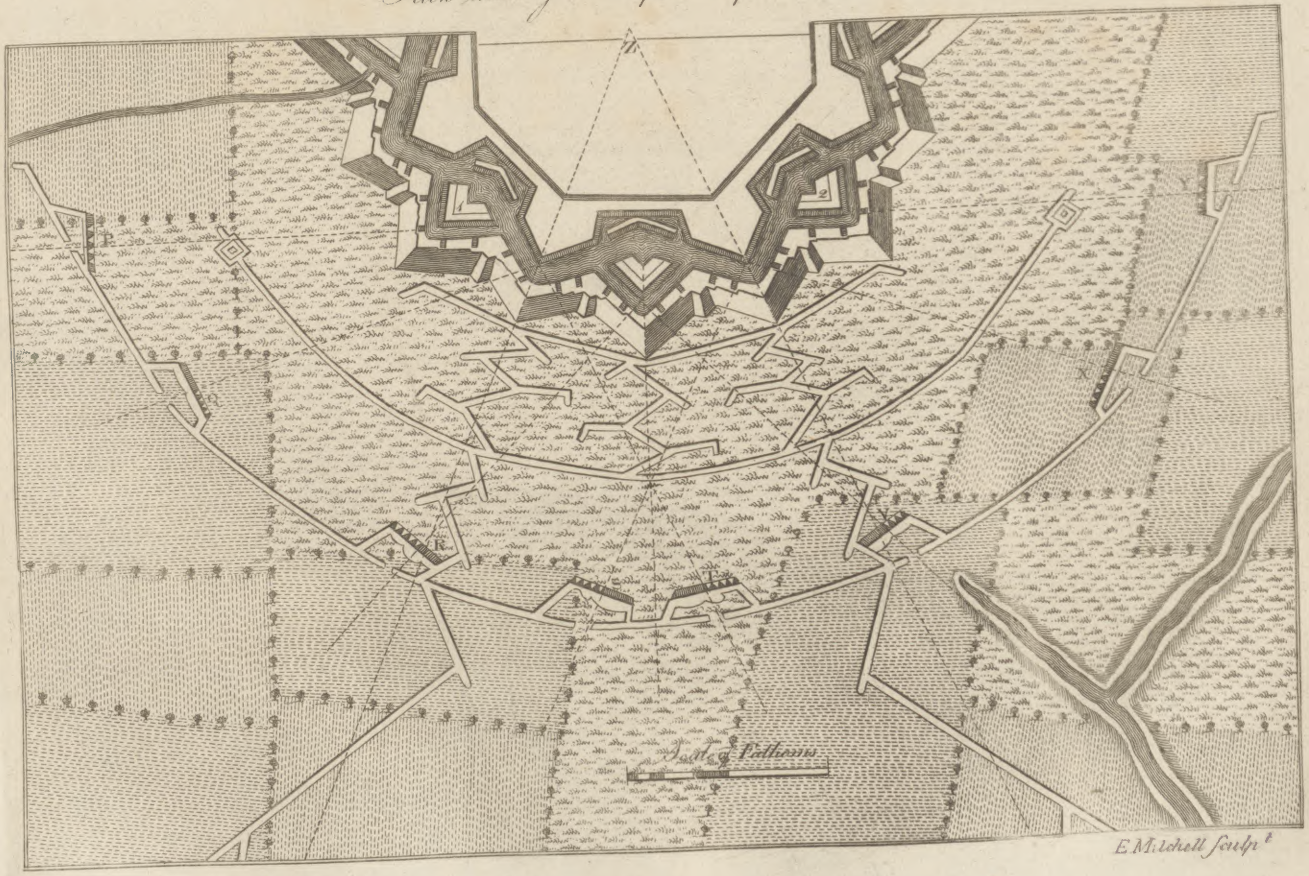
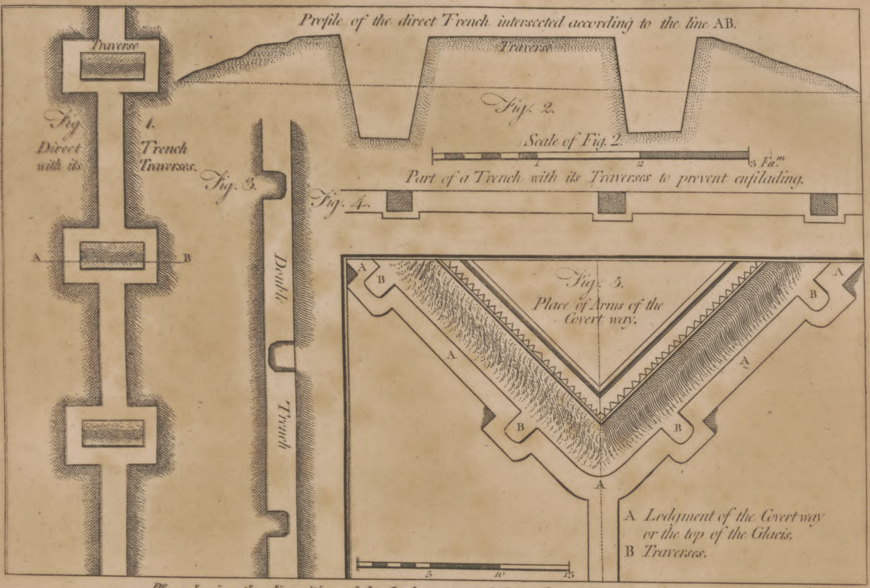


Fig. 3.
Plan shewing the disposition of the Batteries.

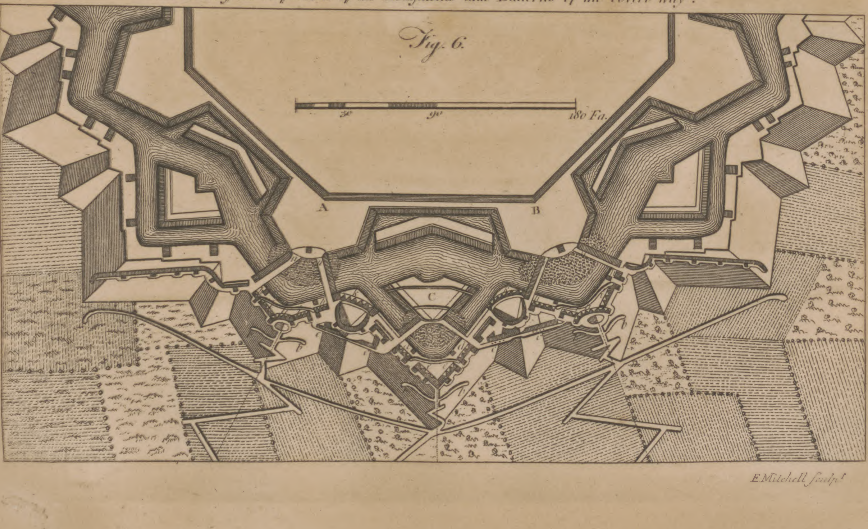


E Mitchell Sculp^t

Attack of Fortified Places.



Plan shewing the disposition of the Ledgments and Batteries of the covert way.



E.Mitchell sculp^t

Plate DLXI

WAR.

Attack of Fortified Places.

Fig. 1.

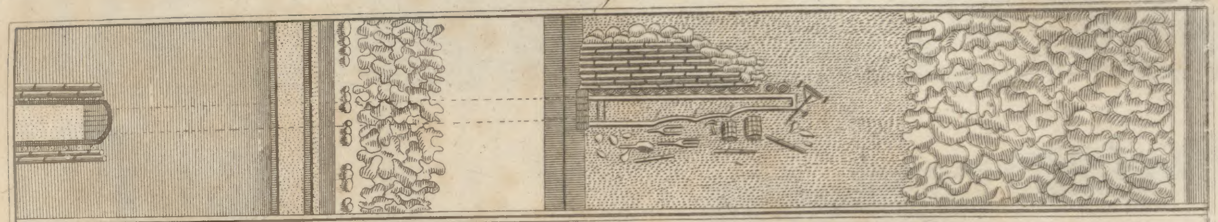
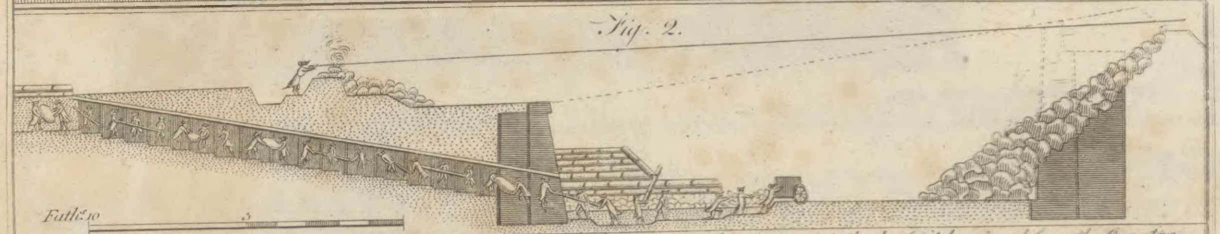


Fig. 2.



Entrance into the descent of a dry Ditch viewed from the top of the Breach.

Opening of the descent into the dry Ditch viewed from the Country.

Fig. 4.

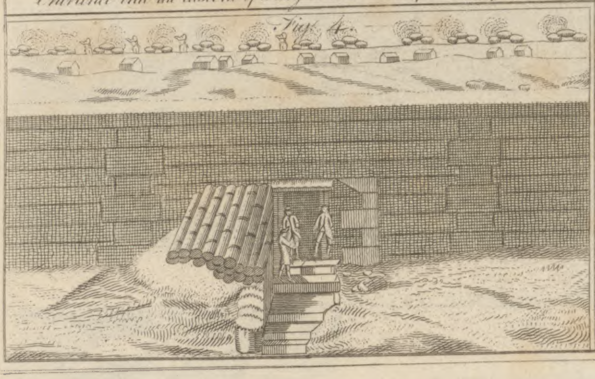
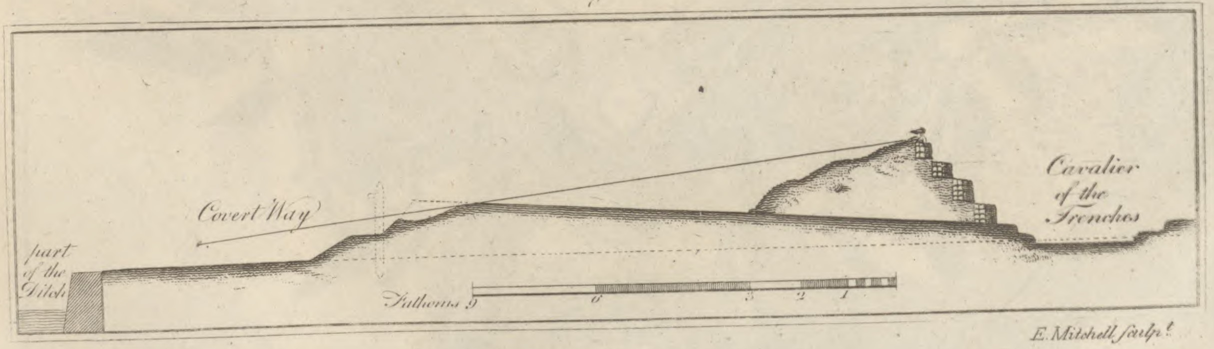


Fig. 3.

Fig. 5.



E. Mitchell sculp.t

WAR
Attack of Fortified Places.

Plate DLXII.

Fig. 1.

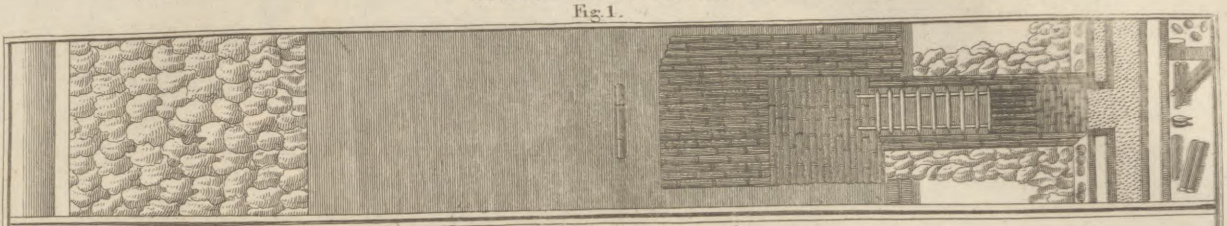
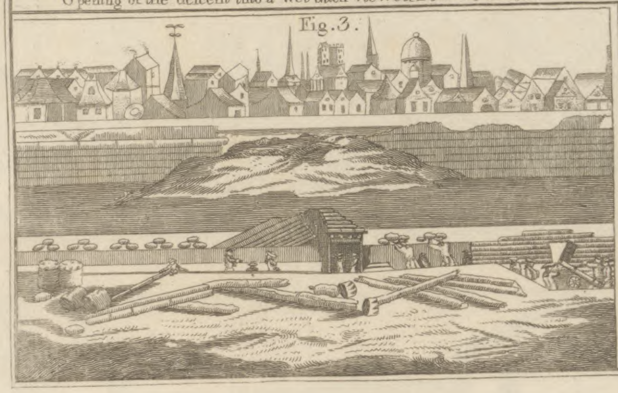


Fig. 2.

Opening of the descent into a wet ditch viewed from the Glacis.

Fig. 3.



Entrance into the descent of the wet ditch viewed from the Breach.

Fig. 4.

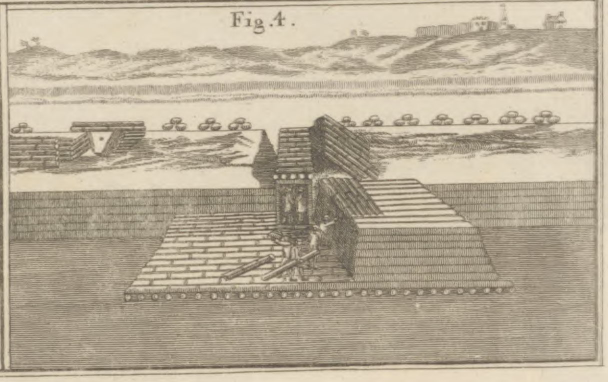
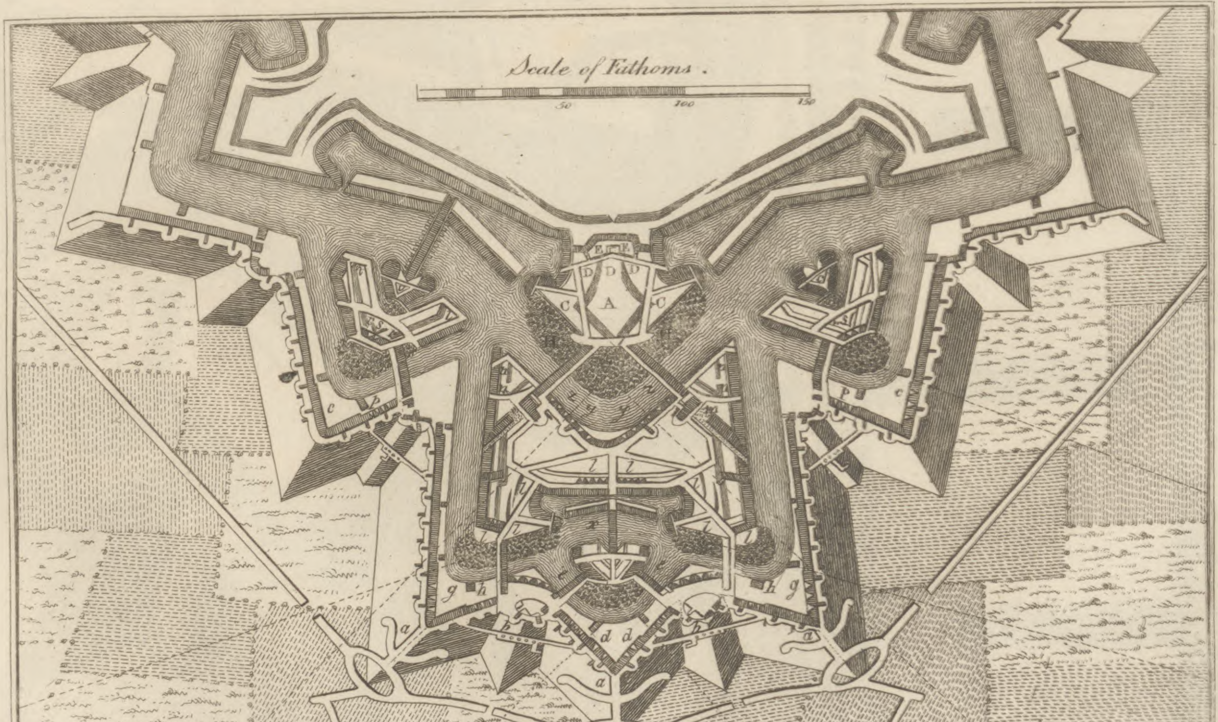


Fig. 5.



E. Mitchell sculp^t.

Fig. 2.

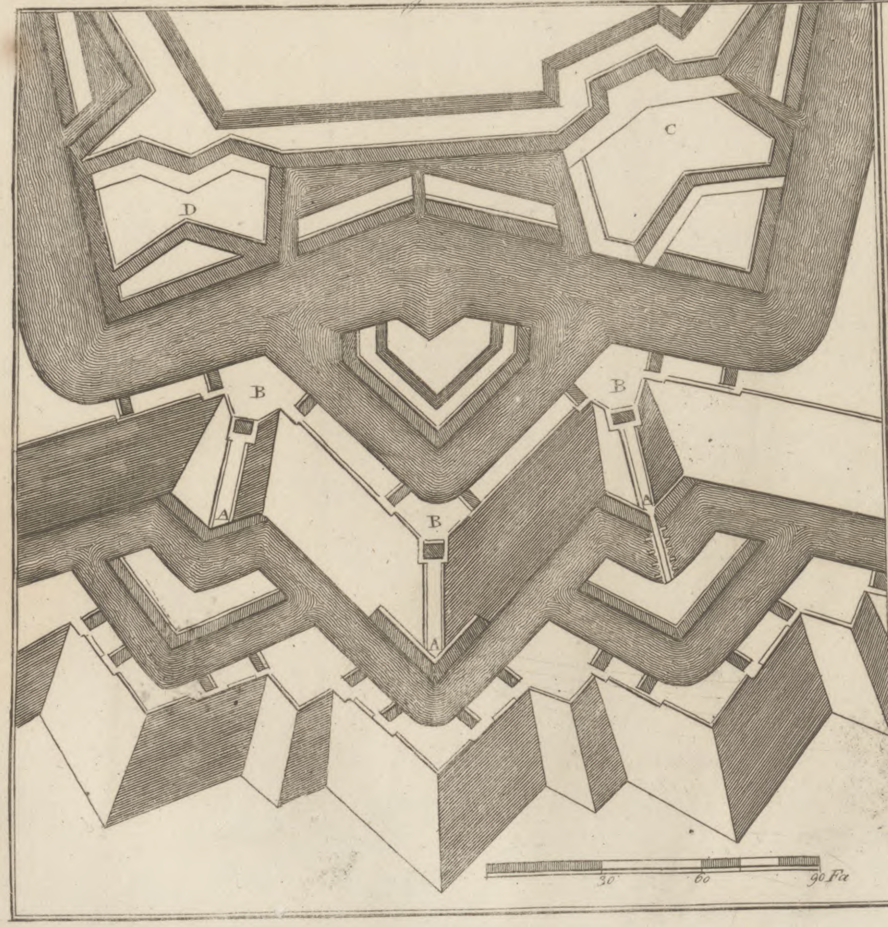
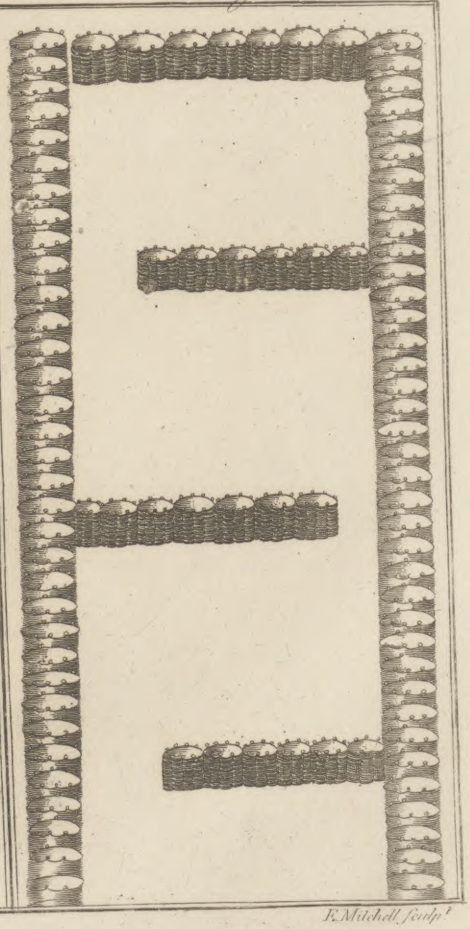


Fig. 3.



E. Mitchell sculp.

Fig. 1.

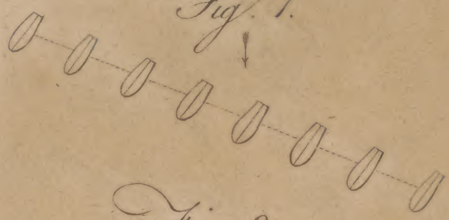


Fig. 2.

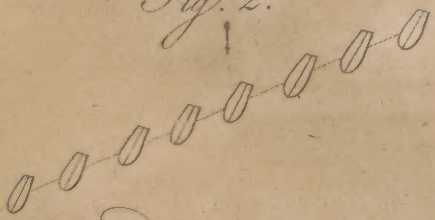


Fig. 3.

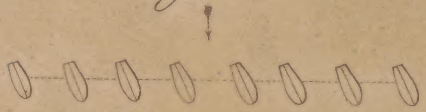


Fig. 4.

Fig. 5.

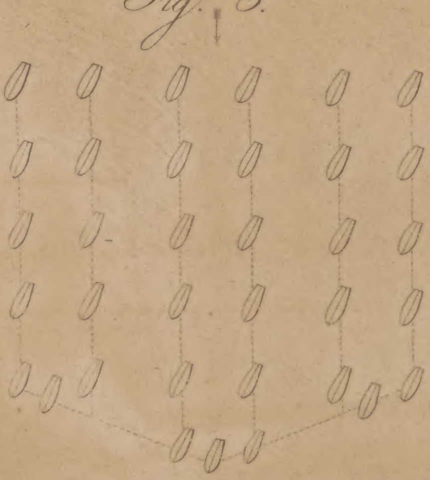


Fig. 6.

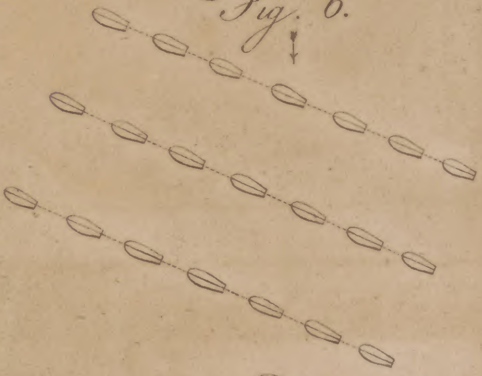


Fig. 10.

Fig. 8.

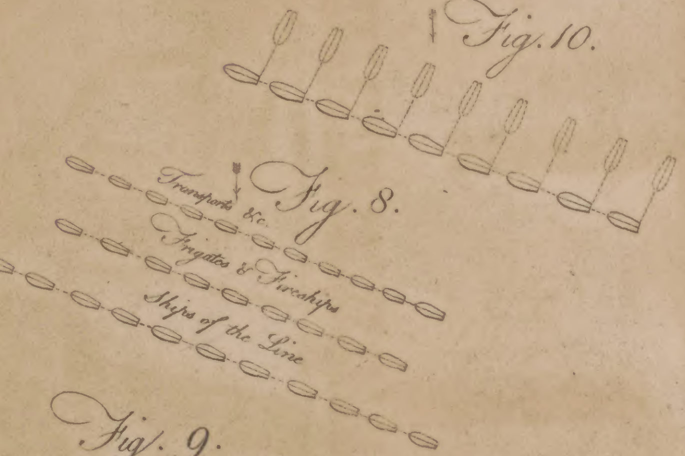


Fig. 7.

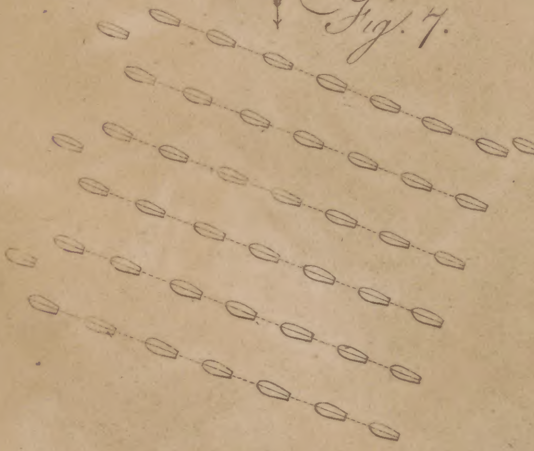
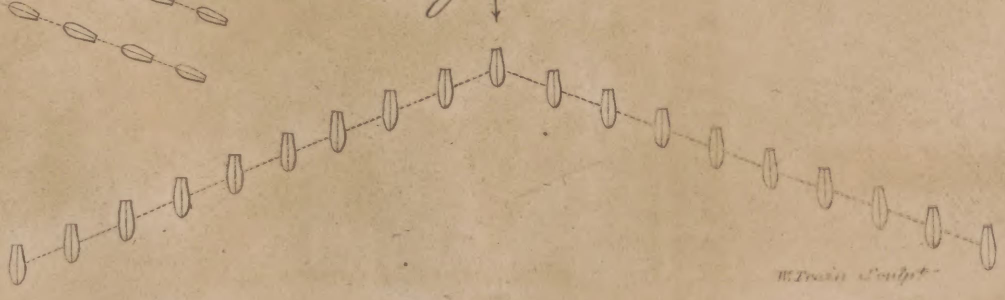
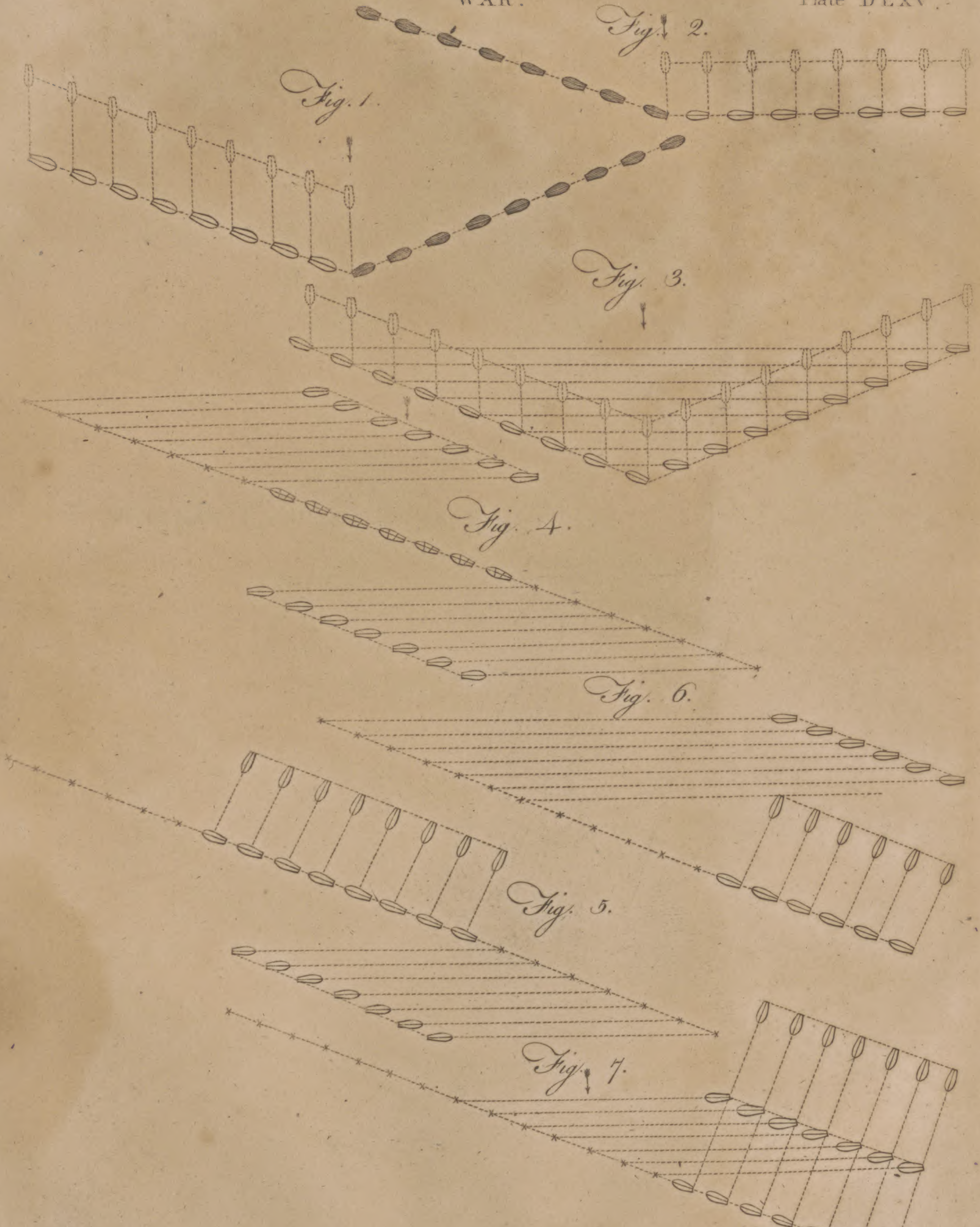


Fig. 9.



W. Tr[illegible] Sculpt.



W. Train Sculpt

Fig. 1.

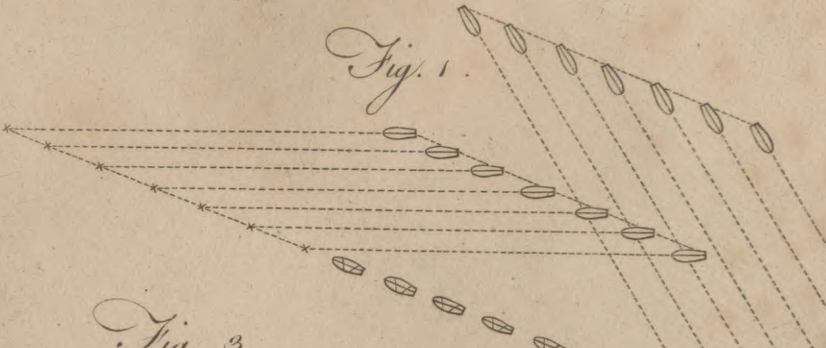


Fig. 5.

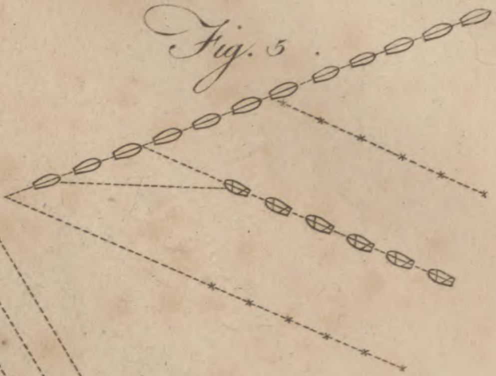


Fig. 3.

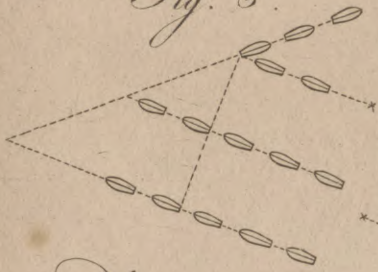


Fig. 2.

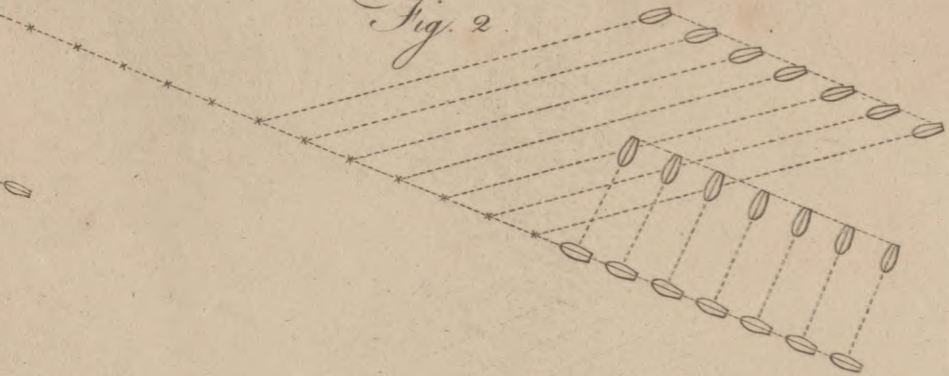


Fig. 4.

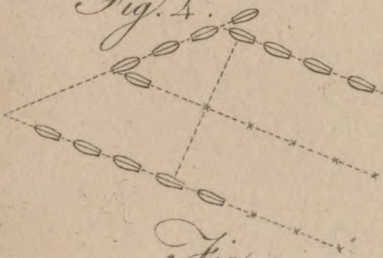


Fig. 9.

Fig. 10.

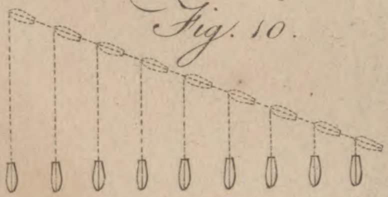
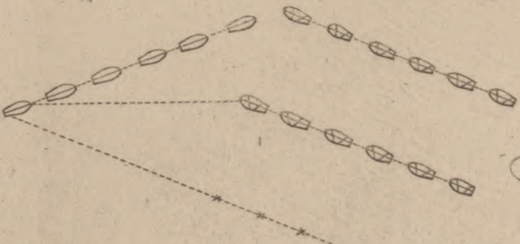


Fig. 6.



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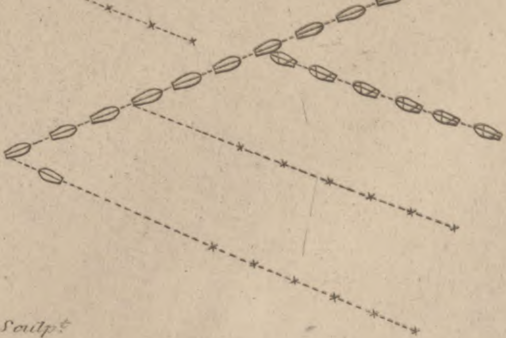

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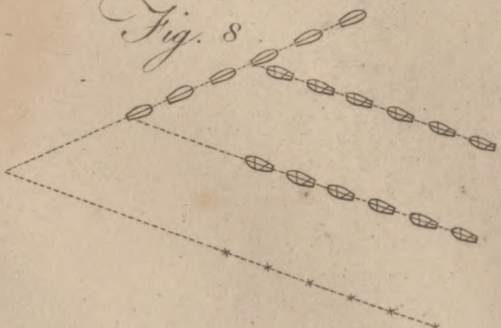
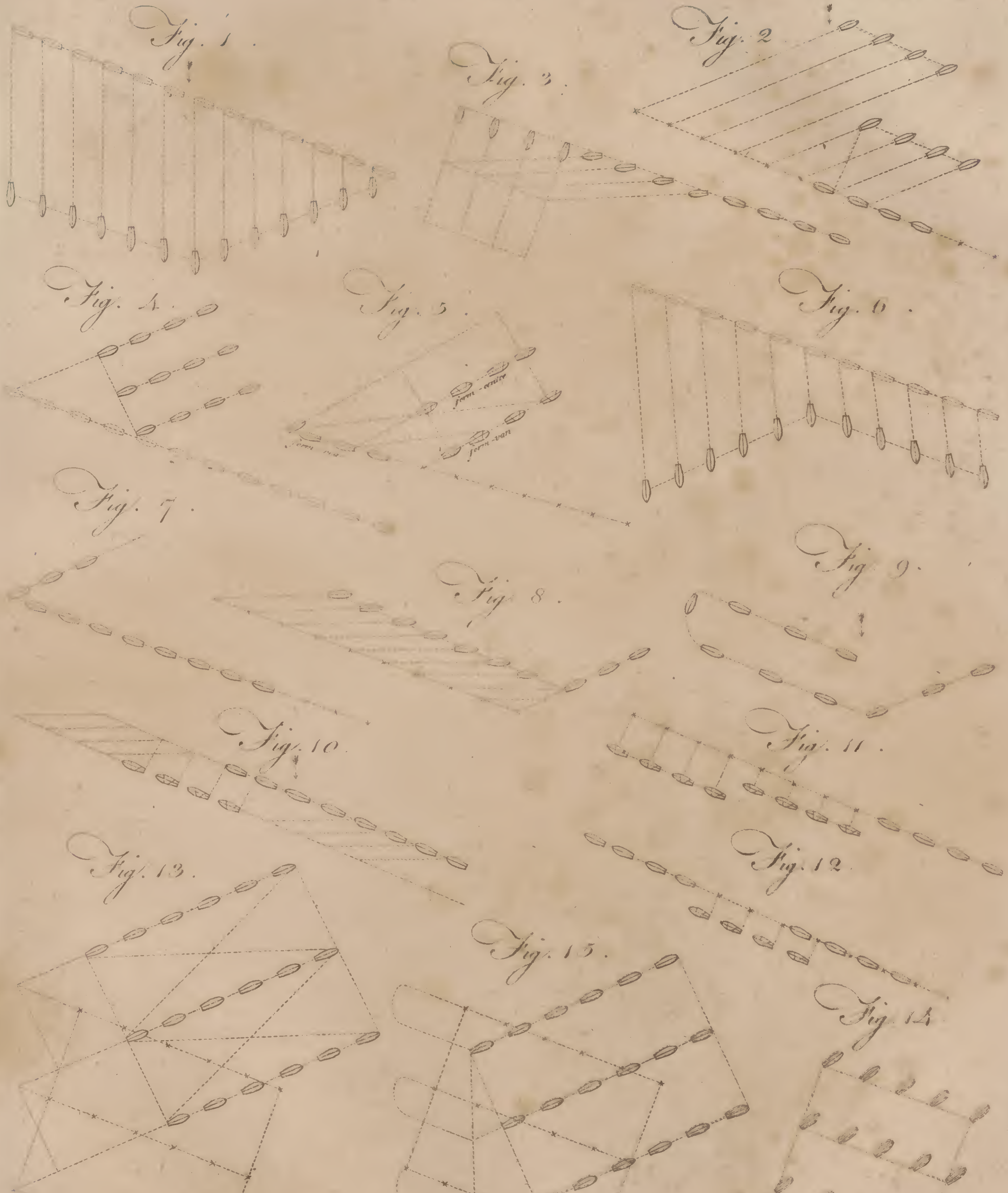


W Train Sculp.t



W. Train Sculpt.

Fig. 1.

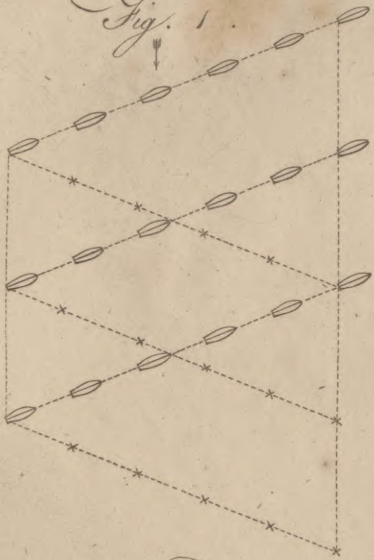


Fig. 2.

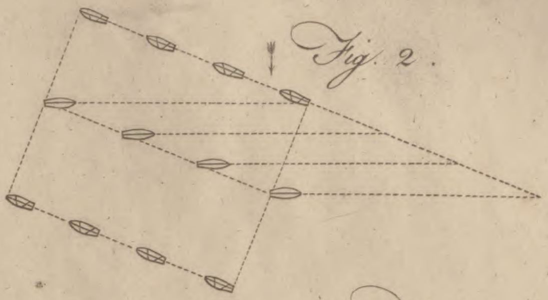


Fig. 6.

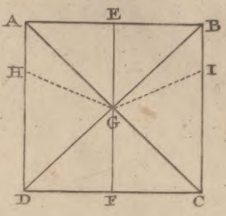
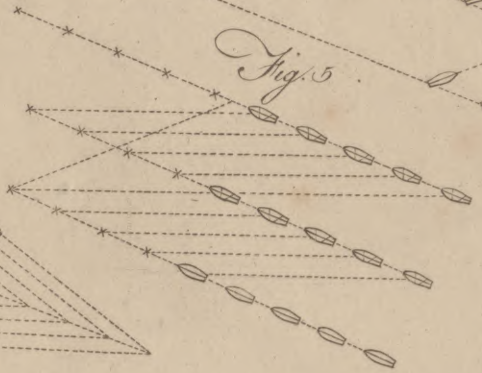


Fig. 4.

Fig. 5.



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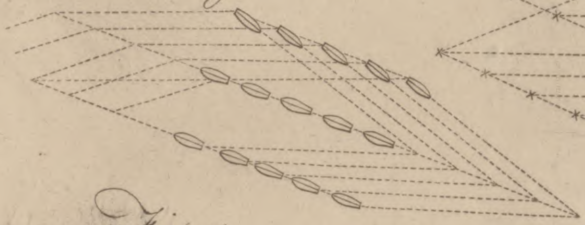


Fig. 7.

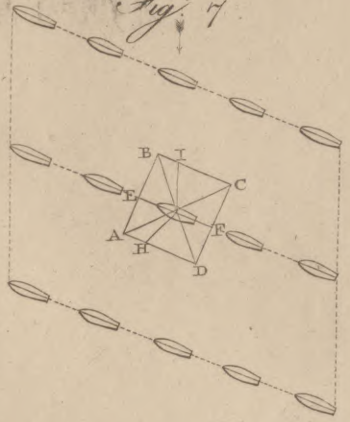


Fig. 10.

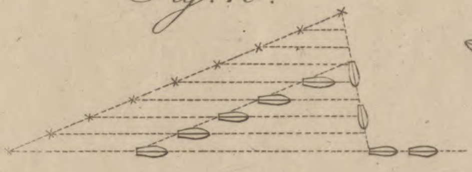
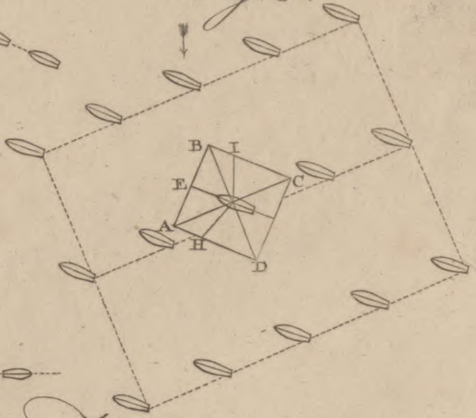


Fig. 8.



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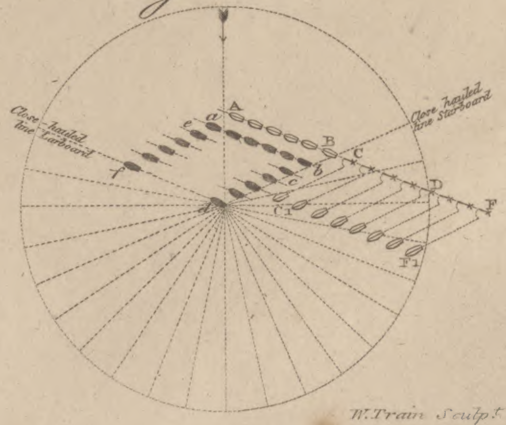


Fig. 9

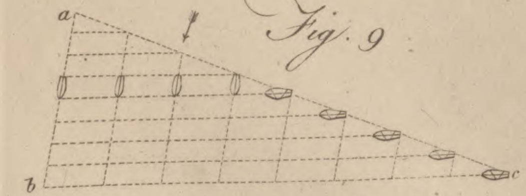
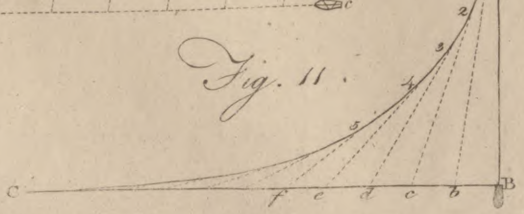


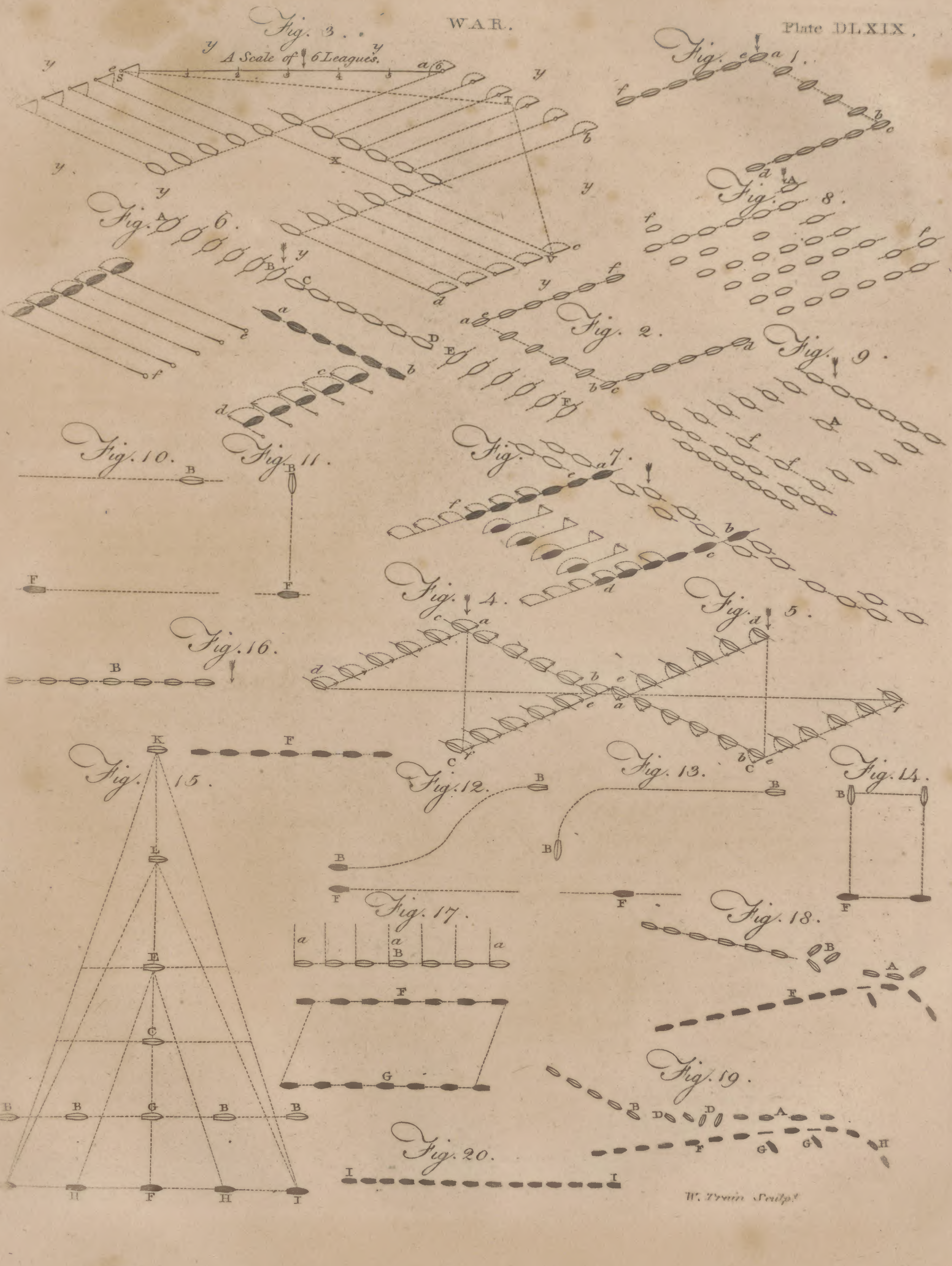
Fig. 11.



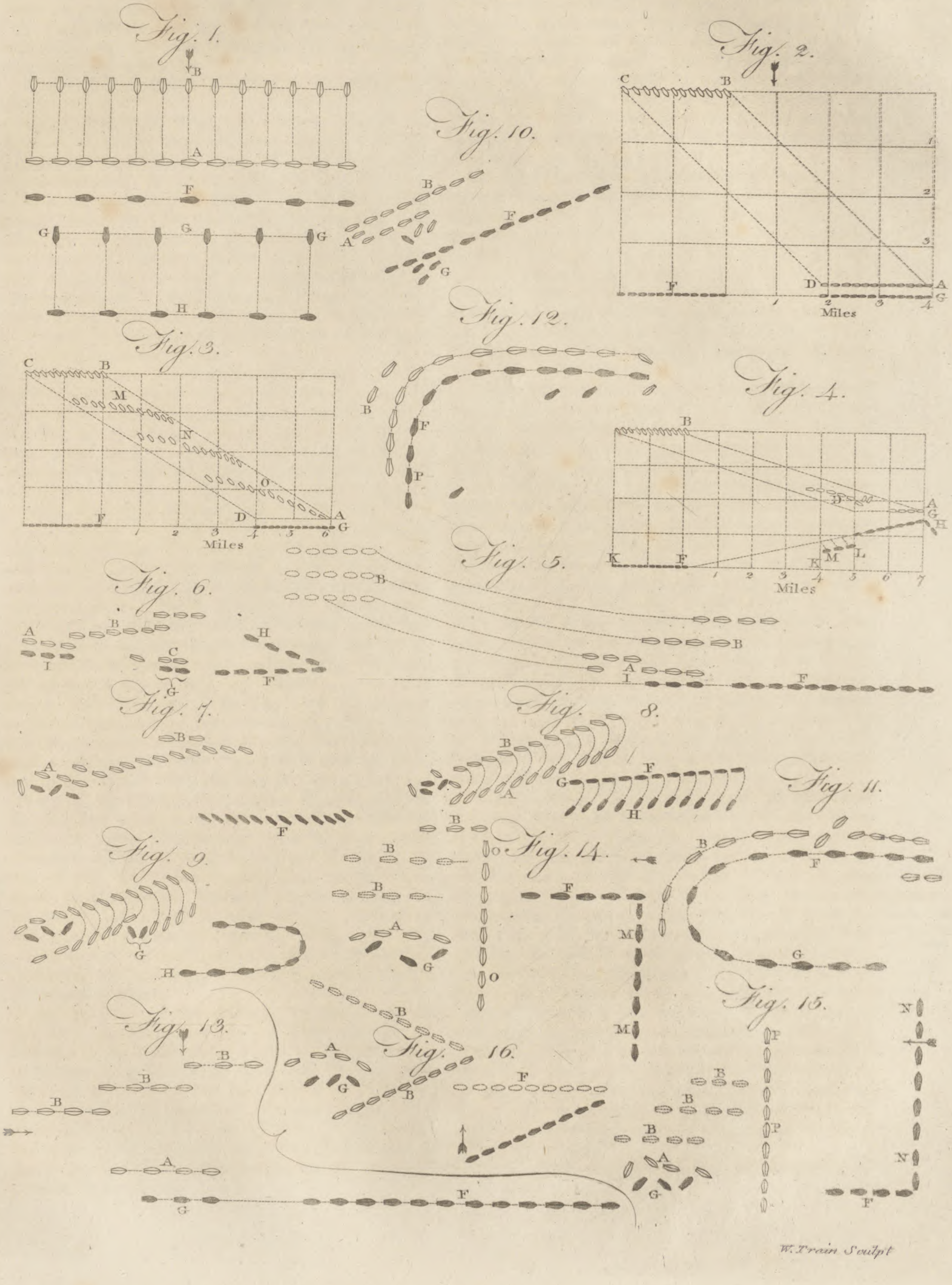
W. Train Sculp^t.

WAR.

Plate DLXIX.



W. Train Sculp.



W. Train Sculpt

Man-of-WAR-Bird. See PELICANUS, ORNITHOLOGY *Index.*

WAR-Cry was formerly cuſtomary in the armies of moſt nations, when juſt upon the point of engaging. Sometimes they were only tumultuous ſhouts, or horrid yells, uttered with an intent to ſtrike terror into their adverſaries; ſuch as is now uſed by the Indians in America, called the *war-whoop.*

WARBLES, a diſeaſe of horſes, ſee FARRIERY *Index.*

WARBURTON, WILLIAM, a learned Engliſh biſhop, was deſcended from an ancient family in Cheſhire, and was the ſecond ſon of George Warburton, an attorney at Newark in the county of Nottingham, was born at Newark, December 24. 1698. He was firſt put to ſchool there under a Mr Twells, but had the chief part of his education at Okeham in Rutlandſhire, where he continued till the beginning of the year 1714, and ſoon after he was put out clerk to an eminent attorney of Great Markham in Nottinghamſhire, where he continued till the year 1719, when he returned to his family at Newark; but whether he practiſed there or elſewhere as an attorney, is not known.

He had always expreſſed a ſtrong inclination to take orders; and the love of letters, which tended to retard, rather than forward, his progreſs in the profeſſion choſen for him by his friends, growing every day ſtronger in him, it was deemed expedient to give way to that inclination. He therefore devoted himſelf to the ſtudies neceſſary to fit him for the church, and at length in 1723 he was ordained deacon, and prieſt in 1727.

In 1728 he was preſented by Sir Robert Sutton to the rectory of Brand-Broughton, in the dioceſe of Lincoln, where he ſpent the greater part of his life, and compoſed all the great works which will carry his fame down to poſterity. In the ſame year he was put upon the king's liſt of Maſters of Arts, erected on his majeſty's viſit to the univerſity of Cambridge. He had already publiſhed ſome juvenile performances, which diſplayed genius and reading, and attracted conſiderable notice; but it was not till the year 1736 that he may be ſaid to have emerged from the obſcurity of a private life into the notice of the world.—The firſt publication which rendered him afterwards famous now appeared, under the title of "The Alliance between Church and State; or, the Neceſſity and Equity of an Eſtabliſhed Religion and a Teſt Law; demonſtrated from the Eſſence and End of Civil Society, upon the fundamental Principles of the Law of Nature and Nations." In this treatiſe, says Biſhop Horſley *, the author "hath ſhown the general good policy of an eſtabliſhment, and the neceſſity of a TEST for its ſecurity, upon principles which republicans themſelves cannot eaſily deny. His work is one of the fineſt ſpecimens that are to be found perhaps in any language, of ſcientific reaſoning applied to a political ſubject."

At the cloſe of the Alliance was announced the ſcheme of the Divine Legation of Moſes, in which he had then made conſiderable progreſs. The firſt volume of this work was publiſhed in January 1737-8, under the title of "The Divine Legation of Moſes demonſtrated on the Principles of a religious Deiſt, from the Omiſſion of the Doctrine of a future State of Rewards and Puniſhments in the Jewiſh Diſpenſation, in ſix books, by William Warburton, M. A. author of the Alliance between Church and State;" and met with a reception which neither the ſubject, nor the manner in which it was treated, ſeemed to authoriſe. It was, as the author afterwards obſerved, fallen upon in ſo outrageous and brutal a manner as had been ſcarce pardonable, had it been "The Divine Legation of Mahomet."—It produced ſeveral anſwers, and ſo much abuſe from the authors of "The Weekly Miſcellany," that in leſs than two months he was conſtrained to defend himſelf, in "A Vindication of the Author of the Divine Legation of Moſes, from the Aſperſions of the Country Clergyman's Letter in the Weekly Miſcellany of February 24. 1737-8, 8vo."

Mr Warburton's extraordinary merit had now attracted the notice of the heir apparent to the crown, in whoſe immediate ſervice we find him in June 1738, when he publiſhed "Faith working by Charity to Chriſtian Edification, a Sermon, preached at the laſt epiſcopal Viſitation for Confirmation in the Dioceſe of Lincoln; with a Preface, ſhowing the Reaſon of its Publication; and a Poſtſcript, occaſioned by ſome Letters lately publiſhed in the Weekly Miſcellany; by William Warburton M. A. Chaplain to his Royal Highneſs the Prince of Wales."

The "Eſſay on Man" had now been publiſhed ſome years; and it is univerſally ſuppoſed, that the author had, in the compoſition of it, adopted the philoſophy of Lord Bolingbroke, whom, on this occaſion, he had followed as his guide, without underſtanding the tendency of his principles. In 1738, M. de Crouſaz wrote ſome remarks on it, accuſing the author of Spinoziſm and Naturaliſm; which falling into Mr Warburton's hands, he publiſhed a defence of the firſt epiſtle, and ſoon after of the remaining three, in ſeven letters; of which ſix were printed in 1739, and the ſeventh in June 1740, under the title of "A Vindication of Mr Pope's Eſſay on Man, by the author of the Divine Legation." The opinion which Mr Pope conceived of theſe defences, as well as of their author, will be beſt ſeen in his letters. In conſequence, a firm friendſhip was eſtabliſhed between them, which continued with undiminiſhed fervour until the death of Mr Pope; who, during the remainder of his life, paid a deference and reſpect to his friend's judgement and abilities, which will be conſidered by many as almoſt bordering on ſervility.

Towards the end of the year 1739, Mr Warburton publiſhed a new and improved edition of the firſt volume of the Divine Legation; and in 1741, appeared the ſecond part, which completed the argument, though not the entire plan of that work. "A work, ſays Biſhop Hurd *, in all views of the moſt tranſcendant merit, whether we conſider the invention or the execution. A plain ſimple argument, yet perfectly new, proving the divinity of the Moſaic law, and laying a ſure foundation for the ſupport of Chriſtianity, is there drawn out to a great length by a chain of reaſoning ſo elegantly connected, that the reader is carried along it with eaſe and pleaſure; while the matter preſented to him is ſo ſtriking for its own importance, ſo embelliſhed by a lively fancy, and illuſtrated from all quarters by exquiſite learning and the moſt ingenious diſquiſition, that in the whole compaſs of modern or ancient theology, there is nothing equal or ſimilar to this extraordinary performance."

This is the panegyric of a man reflecting with ten-

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* *Review of the Caſe of the Proteſtant Diſſenters,* Lond. 1787. PREFACE.

* *Life of Warburton prefixed to his Works.*

derneſs on the memory of his friend and benefactor; but it approaches much nearer to the truth than the cenſures of thoſe cabaliſtic critics, who, faſtening upon ſome weak part of the Divine Legation, or perhaps never having looked into it, have ridiculouſly contended that the author was far from being eminent as a ſcholar, and that his work is inimical to the cauſe of Chriſtianity! Putting partiality aſide, there is in the Divine Legation of Moſes abundant evidence of the malignant folly of this charge, as no man can read and underſtand that work without being convinced that its author was a Chriſtian, not only ſincere but zealous; that he was, what Johnſon calls him *, "a man of vigorous faculties, of a mind fervent and vehement, ſupplied, by unlimited and inceſſant inquiry, with a wonderful extent and variety of knowledge, which had neither depreſſed his imagination nor clouded his perſpicuity; and that to every work, and this work in particular, he brought a memory full fraught, with a fancy fertile of original combinations, exerting at once the powers of the ſcholar, the reaſoner, and the wit." But we think it muſt be acknowledged, that his learning was too multifarious to be always exact, and his inquiries too eagerly puſhed to be always cautious. We have no heſitation, however, to ſay, that to the divine this great work, with all its imperfections, is, in our opinion, one of the moſt valuable that is to be found in any language.

In the ſummer 1741, Mr Pope and Mr Warburton, in a country ramble, took Oxford in their way. The univerſity was naturally pleaſed at the arrival of two ſuch ſtrangers, and ſeemed deſirous of enrolling their names among their graduates. The degree of D. D. was intended for the divine, and that of LL. D. for the poet: but intrigue and envy defeated this ſcheme; and the univerſity loſt the honour of decorating at the ſame time the two greateſt geniuſes of the age, by the fault of one or two of its members. Pope retired with ſome indignation to Twickenham, where he conſoled himſelf and his friend with this ſarcaſtic reflection—"We ſhall take our degree together in fame, whatever we do at the univerſity."

The friendſhip of this eminent poet was of ſervice to Mr Warburton in more reſpects than that of increaſing his fame. He introduced and warmly recommended him to moſt of his friends, and among others to Mr Murray, afterwards earl of Mansfield, and Ralph Allen, Eſq. of Prior-park. In conſequence of this introduction, we find Mr Warburton at Bath 1742; where he printed a ſermon which had been preached at the Abbey-church on the 24th of October, for the benefit of Mr Allen's favourite Charity, the General Hoſpital or Infirmary. In this year alſo he printed a Diſſertation on the origin of books of chivalry, at the end of Jarvis's Preface to a tranſlation of Don Quixote, which Mr Pope tells him, he had not got over two paragraphs of, before he cried out, *Aut Eraſmus, aut Diabolus.*

In 1742, Mr Warburton publiſhed "A Critical and Philoſophical Commentary on Mr Pope's Eſſay on Man, in which is contained a Vindication of the ſaid Eſſay from the Miſrepreſentation of M. de Reſnal, the French Tranſlator, and of M. de Crouſaz, Profeſſor of Philoſophy and Mathematics in the Academy of Lauſanne, the Commentator." It was at this period, when Mr Warburton had the entire confidence of Mr Pope, that he adviſed him to complete the Dunciad, by changing the hero, and adding to it a fourth book. This was accordingly executed in 1742, and publiſhed early in 1743, with notes by our author; who, in conſequence of it, received his ſhare of the abuſe which Mr Cibber liberally beſtowed on both Mr Pope and his annotator. In the latter end of the ſame year he publiſhed complete editions of "The Eſſay on Man," and "The Eſſay on Criticiſm;" and from the ſpecimen which he there exhibited of his abilities, it may be preſumed Mr Pope determined to commit the publication of thoſe works which he ſhould leave to Mr Warburton's care. At Mr Pope's deſire, he, about this time, reviſed and corrected the "Eſſay on Homer," as it now ſtands in the laſt edition of that tranſlation.

The publication of "The Dunciad" was the laſt ſervice which our author rendered Mr Pope in his lifetime. After a lingering and tedious illneſs, the event of which had been long foreſeen, this great poet died on the 30th of May 1744; and by his will, dated the 12th of the preceding December, bequeathed to Mr Warburton one half of his library, and the property of all ſuch of his works already printed as he had not otherwiſe diſpoſed of or alienated, and all the profits which ſhould ariſe from any edition to be printed after his death: but at the ſame time directed that they ſhould be publiſhed without any future alterations.

"In 1744, Mr Warburton turned his attention to the ſeveral attacks which had been made on the "Divine Legation," and defended himſelf in a manner which, if it did not prove him to be poſſeſſed of much humility or diffidence, at leaſt demonſtrated, that he knew how to wield the weapons of controverſy with the hand of a maſter. His firſt defence now appeared, under the title of "Remarks on ſeveral occaſional Reflections, in Anſwer to the Reverend Dr Middleton, Dr Pococke, the Maſter of the Charter-Houſe, Dr Richard Grey, and others; ſerving to explain and juſtify divers Paſſages in the Divine Legation, objected to by thoſe learned Writers. To which is added, A General Review of the Argument of the Divine Legation, as far as it is yet advanced; wherein is conſidered the Relation the ſeveral Parts bear to each other and the whole. Together with an Appendix, in Anſwer to a late Pamphlet intitled, An Examination of Mr W——'s ſecond Propoſition." This was followed next year by "Remarks on ſeveral occaſional Reflections, in Anſwer to the Reverend Doctors Stebbing and Sykes; ſerving to explain and juſtify the Two Diſſertations in the Divine Legation, concerning the Command to Abraham to offer up his Son, and the Nature of the Jewiſh Theocracy, objected to by theſe learned Writers. Part II. and laſt." Both theſe anſwers are couched in thoſe high terms of confident ſuperiority, which marked almoſt every performance that fell from his pen during the remainder of his life.

On the 5th of September 1745, the friendſhip between him and Mr Allen was more cloſely cemented by his marriage with Miſs Tucker, who ſurvived, and is now, if alive, Mrs Stafford Smith of Prior-park. At that important criſis our author preached and publiſhed three ſeaſonable ſermons: 1. "A faithful Portrait of Popery, by which it is ſeen to be the Reverſe of Chriſtianity, as it is the Deſtruction of Morality, Piety, and Civil Liberty. Preached at St James's, Weſtminſter,

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* Life of Pope.

October 1745." 2. "A Sermon occaſioned by the preſent unnatural Rebellion, &c. Preached in Mr Allen's Chapel at Prior-park, near Bath, November 1745." 3. "The Nature of National Offences truly ſtated.—Preached on the General Faſt-day, Dec. 18. 1745-6." On account of the laſt of theſe ſermons, he was again involved in a controverſy with his former antagoniſt Dr Stebbing, which occaſioned "An Apologetical Dedication to the Reverend Dr Henry Stebbing, in Anſwer to his Cenſure and Miſrepreſentations of the Sermon preached on the General Faſt, &c."

Notwithſtanding his great connections, his acknowledged abilities, and his eſtabliſhed reputation, a reputation founded on the durable baſis of learning, and upheld by the decent and attentive performance of every duty incident to his ſtation; yet we do not find that he received any addition to the preferments given him in 1728 by Sir Robert Sutton (except the chaplainſhip to the prince of Wales), until April 1746, when he was unanimouſly called by the Society of Lincoln's Inn to be their preacher. In November he publiſhed "A Sermon preached on the Thanſgiving appointed to be obſerved the 9th of October, for the Suppreſſion of the late unnatural Rebellion." In 1747 appeared his edition of Shakeſpeare and his Preface to Clariſſa; and in the ſame year he publiſhed, 1. "A Letter from an Author to a Member of Parliament concerning Literary Property." 2. "Preface to Mrs Cockburn's Remarks upon the Principles and Reaſonings of Dr Rutherford's Eſſay on the Nature and Obligations of Virtue, &c." 3. "Preface to a Critical Inquiry into the Opinions and Practice of the ancient Philoſophers, concerning the Nature of a Future State, and their Method of teaching by double Doctrine," (by Mr Towne) 1747, ſecond edition. In 1748, a third edition of "The Alliance between Church and State, corrected and enlarged."

"In 1749, a very extraordinary attack was made on the moral character of Mr Pope, from a quarter where it could be leaſt expected. An inſignificant pamphlet, under the name of *A Patriot King*, was that year publiſhed by Lord Bolingbroke, or by his direction, with a preface to it, reflecting highly on Mr Pope's honour. The provocation was ſimply this: The manuſcript of that trivial declamation had been intruſted to the care of Mr Pope, with the charge (as it was pretended) that only a *certain* number of copies ſhould be printed. Mr Pope, in his exceſſive admiration of his *guide*, *philoſopher*, and friend, took that opportunity, for fear ſo invaluable a treaſure of patriot eloquence ſhould be loſt to the public, to exceed his commiſſion, and to run off more copies, which were found, after his death, in the printer's warehouſe. This charge, however frivolous, was aggravated beyond meaſure; and, notwithſtanding the proofs which Lord Bolingbroke had received of Pope's devotion to him, envenomed with the utmoſt malignity. Mr Warburton thought it became him to vindicate his deceaſed friend; and he did it ſo effectually, as not only to ſilence his accuſer, but to cover him with confuſion *."

About this time the publication of Dr Middleton's Inquiry concerning the miraculous Powers of the Chriſtian Church, gave riſe to a controverſy, which was managed with great warmth and aſperity on both ſides, and not much to the credit of either party. On this occaſion Mr Warburton publiſhed an excellent performance, written with a degree of candour and temper, which, it is to be lamented, he did not always exerciſe. The title of it was "Julian; or a Diſcourſe concerning the Earthquake and fiery Eruption which defeated that Emperor's attempt to rebuild the Temple at Jeruſalem, 1750." A ſecond edition of this diſcourſe, "with Additions," appeared in 1751, in which year he gave the public his edition of Mr Pope's Works, with Notes, in nine volumes 8vo; and in the ſame year printed "An Anſwer to a Letter to Dr Middleton, inſerted in a Pamphlet intitled, The Argument of the Divine Legation fairly ſtated," &c.; and "An Account of the Prophecies of Ariſe Evans, the Welſh Prophet in the laſt Century," annexed to the firſt volume of Dr Jortin's Remarks on Eccleſiaſtical Hiſtory, which afterwards ſubjected him to much trouble.

In 1752, Mr Warburton publiſhed the firſt volume of a courſe of ſermons, preached at Lincoln's Inn, intitled, "The Principles of Natural and Revealed Religion, occaſionally opened and explained;" and this was two years afterwards followed by a ſecond. After the public had been ſome time promiſed, it may, from the alarm which was taken, be almoſt ſaid threatened with, the appearance of Lord Bolingbroke's Works, they were about this time printed. The known abilities and infidelity of this nobleman had created apprehenſions in the minds of many people, of the pernicious effects of his doctrines; and nothing but the appearance of his whole force could have convinced his friends, how little there was to be dreaded from arguments againſt religion ſo weakly ſupported. Many anſwers were ſoon publiſhed, but none with more acuteneſs, ſolidity, and ſprightlineſs, than "A View of Lord Bolingbroke's Philoſophy, in two Letters to a Friend, 1754;" the third and fourth letters were publiſhed in 1755, with another edition of the two former; and in the ſame year a ſmaller edition of the whole; which, though it came into the world without a name, was univerſally aſcribed to Mr Warburton, and afterwards publicly owned by him. To ſome copies of this is prefixed an excellent complimentary epiſtle from the preſident Monteſquieu, dated May 26. 1754.

At this advanced period of his life, that preferment which his abilities might have claimed, and which had hitherto been withheld, ſeemed to be approaching towards him. In September 1754, he was appointed one of his majeſty's chaplains in ordinary; and in the next year was preſented to a prebend in the cathedral of Durham. About this time the degree of Doctor of Divinity was conferred on him by Dr Herring, then archbiſhop of Canterbury. A new impreſſion of The Divine Legation being now called for, he printed a fourth edition of the firſt part of it, corrected and enlarged, divided into two volumes, with a dedication to the earl of Hardwicke. The ſame year appeared "A Sermon preached before his Grace Charles Duke of Marlborough, Preſident, and the Governors of the Hoſpital for the Smallpox and for Inoculation, at the Pariſh-church of St Andrew, Holborn, April the 24th, 1755." And in 1756, Natural and Civil Events the Inſtruments of God's Moral Government; a Sermon, preached on the laſt public Faſt-day, at Lincoln's Inn Chapel."

In 1757, Dr Warburton meeting with Mr Hume's

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* Hurd's Life of Warburton.

tract, entitled, The Natural Hiſtory of Religion, filled the margin of the book, as well as ſome interleaved ſlips of paper, with many ſevere and ſhrewd remarks on the infidelity and naturaliſm of the author. Theſe he put into the hands of his friend Dr Hurd, who, making a few alterations of the ſtyle, added a ſhort introduction and concluſion, and publiſhed them in a pamphlet, entitled, "Remarks on Mr David Hume's Natural Hiſtory of Religion, by a Gentleman of Cambridge, in a Letter to the Reverend Dr Warburton." This lively attack upon Mr Hume gave him ſo much offence, that he thought proper to vent his ſpleen on the ſuppoſed author, in the poſthumous diſcourſe which he called his *Life*; and thus to do greater honour to Dr Hurd than to any other of his numerous antagoniſts.

Towards the end of the year 1757, Dr Warburton was promoted to the deanery of Briſtol; and in the beginning of the year 1760, he was, through Mr Allen's intereſt with Mr Pitt, afterwards earl of Chatham, advanced to the biſhopric of Glouceſter. That great miniſter is known to have declared, "that nothing of a private nature, ſince he had been in office, had given him ſo much pleaſure as bringing our author on the bench." There was, however, another miniſter, who dreaded his promotion, and thought he ſaw a ſecond Atterbury in the new biſhop of Glouceſter; but Warburton, ſays Biſhop Hurd, had neither talents nor inclination for parliamentary intrigue or parliamentary eloquence: he had other inſtruments of fame in his hands, and was infinitely above the vanity of being caught

"With the fine notion of a buſy man *."

He was conſecrated on the 20th of January 1760, and on the 30th of the ſame month preached before the houſe of lords. In the next year he printed "A Rational Account of the Nature and End of the Sacrament of the Lord's Supper." In 1762, he publiſhed "The Doctrine of Grace; or the Office and Operations of the Holy Spirit vindicated from the Inſults of Infidelity and the Abuſes of Fanaticiſm, 2 vols 12mo; and in the ſucceeding year drew upon himſelf much illiberal abuſe from ſome writers of the popular party, on occaſion of his complaint in the houſe of lords, on the 15th of November 1763, againſt Mr Wilkes, for putting his name to certain notes on the infamous "Eſſay on Woman."

In 1765 he publiſhed a new edition of the ſecond part of the Divine Legation, in three volumes; and as it had now received his laſt hand, he preſented it to his great friend Lord Mansfield, in a dedication which deſerves to be read by every perſon who eſteems the well-being of ſociety as a concern of any importance. It was the appendix to this edition which produced the well-known controverſy between him and Dr Lowth, which we have noticed elſewhere (ſee LOWTH), as doing no great honour, by the mode in which it was conducted, to either party. In the next year he gave a new and much improved edition of the Alliance between the Church and State. This was followed, in 1767, by a third volume of ſermons, to which is added, his firſt Triennial Charge to the Clergy of the Dioceſe of Glouceſter; which may be ſafely pronounced one of the moſt valuable diſcourſes of the kind that is to be found in our own or any other language. With this publication he cloſed his literary courſe; except that he made an effort towards publiſhing, and actually printed, the ninth and laſt book of the Divine Legation. This book, with one or two occaſional ſermons, and ſome valuable directions for the ſtudy of *theology*, have been given to the world in the ſplendid edition of his works in ſeven volumes 4to, by his friend and biographer the preſent biſhop of Worceſter. That prelate confeſſes, that the ninth book of the Divine Legation diſplays little of that vigour of mind and fertility of invention which appear ſo conſpicuous in the former volumes; but he adds, perhaps truly, that under all the diſadvantages with which it appears, it is the nobleſt effort which has hitherto been made to give a *rationale* of Chriſtianity.

While the biſhop of Glouceſter was thus exerting his laſt ſtrength in the cauſe of religion, he projected a method by which he hoped to render it effectual ſervice after his death. He transferred 500l. to Lord Mansfield, Sir Eardley Wilmot, and Mr Charles Yorke, upon truſt, to found a lecture, in the form of a courſe of ſermons, to prove the truth of revealed religion in general, and of the Chriſtian in particular, from the completion of the prophecies in the Old and New Teſtament, which relate to the Chriſtian church, eſpecially to the apoſtacy of Papal Rome. To this foundation we owe the admirable Introductory Lectures of Hurd, and the well-adapted Continuation of Halifax and Bagot.

It is a melancholy reflection, that a life ſpent in the conſtant purſuit of knowledge, frequently terminates in the loſs of thoſe powers, the cultivation and improvement of which are attended to with too ſtrict and unabated a degree of ardour. This was the caſe with Dr Warburton; and it ſeems probable that this decline of intellectual vigour was aggravated by the loſs of his only ſon, a promiſing young man, who died of a conſumption but a ſhort time before the biſhop, who himſelf reſigned to fate in the year 1779, and in the 81ſt of his age. A neat marble monument was erected to his memory in the cathedral of Glouceſter.

WARD, Dr SETH, an Engliſh prelate, chiefly diſtinguiſhed for his knowledge in mathematics and aſtronomy, was born at Buntingford in Hertfordſhire, about the year 1617. He was admitted of Sidney college, Cambridge, where he applied with great vigour to his ſtudies, particularly to the mathematics, and was choſen fellow of his college. He was much involved in the conſequences of the civil war, but ſoon after the Reſtoration obtained the biſhopric of Exeter; in 1667, he was tranſlated to Saliſbury; and in 1671 was made chancellor of the order of the garter; he was the firſt Proteſtant biſhop that enjoyed that honour, and he procured it to be annexed to the ſee of Saliſbury. Biſhop Ward was one of thoſe unhappy perſons who have the misfortune to ſurvive their ſenſes, which happened in conſequence of a fever ill cured; he lived to the Revolution, without knowing any thing of the matter, and died in 1690. He was the author of ſeveral Latin works in mathematics and aſtronomy, which were thought excellent in their day; but their uſe has been ſuperſeded by later diſcoveries and the Newtonian philoſophy.

WARD, is variouſly uſed in our old books: a ward in London is a diſtrict or diviſion of the city, committed to the ſpecial charge of one of the aldermen; and in London there are 26 wards, according to the number of the mayor and aldermen, of which every one has his

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* *Dryden.*

his ward for his proper guard and juriſdiction. A foreſt is divided into wards; and a priſon is called a *ward*. Laſtly, the heir of the king's tenant, that held *in capite*, was termed a *ward* during his nonage; but this wardſhip is taken away by the ſtatute 12 Car. II. c. 24.

WARD-Holding, in *Scots Law*. See LAW, N° clxv. 1. and clxvi. 3.

WARD-Hook, or *Wadd-hook*, in *Gunnery*, a rod or ſtaff, with an iron end turned ſerpentwiſe, or like a ſcrew, to draw the wadding out of a gun when it is to be unloaded.

WARDEN, or GUARDIAN, one who has the charge or keeping of any perſon, or thing, by office. Such is the warden of the Fleet, the keeper of the Fleet priſon; who has the charge of the priſoners there, eſpecially ſuch as are committed from the court of chancery for contempt.

WARDHUYS, a port of Norwegian Lapland, 120 miles ſouth-eaſt of the North Cape. E. Long. 31. 12. N. Lat. 70. 23.

WARDMOTE, in London, is a court ſo called, which is kept in every ward of the city; anſwering to the *curiata comitia* of Rome.

WARDROBE, a cloſet or little room adjoining to a bedchamber, ſerving to diſpoſe and keep a perſon's apparel in; or for a ſervant to lodge in, to be at hand to wait, &c.

WARDROBE, in a prince's court, is an apartment wherein his robes, wearing apparel, and other neceſſaries, are preſerved under the care and direction of proper officers.

In Britain, the *Maſter or Keeper of the Great Wardrobe* was an officer of great antiquity and dignity. High privileges and immunities were conferred on him by King Henry VI. which were confirmed by his ſucceſſors; and King James I. not only enlarged them, but ordained that this office ſhould be a corporation or body politic for ever.

Beatſon's Political Index, vol. ii.

It was the duty of this office to provide robes for the coronations, marriages, and funerals of the royal family; to furniſh the court with hangings, cloths of ſtate, carpets, beds, and other neceſſaries; to furniſh houſes for ambaſſadors at their firſt arrival; cloths of ſtate, and other furniture, for the lord lieutenant of Ireland, and all his majeſty's ambaſſadors abroad; to provide all robes for foreign knights of the garter, robes for the knights of the garter at home; robes and all other furniture for the officers of the garter; coats for kings, heralds, and purſuivants at arms; robes for the lords of the treaſury, and chancellor of the exchequer, &c.; livery for the lord chamberlain, grooms of his majeſty's privy chamber, officers of his majeſty's robes; for the two chief juſtices, for all the barons of the exchequer, and ſeveral officers of theſe courts; all liveries for his majeſty's ſervants, as yeomen of the guard, and wardens of the Tower, trumpeters, kettle-drummers, and fifes; the meſſengers, and all belonging to the ſtables, as coachmen, footmen, littermen, poſtilions, and grooms, &c. all the king's coaches, chariots, harneſſes, ſaddles, bits, bridles, &c. the king's watermen, game-keepers, &c. alſo furniture for the royal yachts, and all rich embroidered tilts, and other furniture for the barges.

Beſides the maſter or keeper of the wardrobe, who had a ſalary of 2000l. there was his deputy, who had 150l. and a comptroller and a patent clerk, each of whom has a ſalary of 300l. Beſides many other inferior officers and ſervants, who were all ſworn ſervants to the king.

There was likewiſe a removing wardrobe, who had its own ſet of officers, and ſtanding wardrobe-keepers at St James's, Windſor Caſtle, Hampton Court, Kenſington, and Somerſet Houſe; but the whole of the wardrobe eſtabliſhment was aboliſhed by act of parliament in 1782, and the duty of it in future to be done by the lord chamberlain.

WARDSHIP, in chivalry, one of the incidents of tenure by knight-ſervice. See *FEODAL Syſtem*, *KNIGHT Service*, and TENURE.

Upon the death of a tenant, if the heir was under the age of 21, being a male, or 14, being a female, the lord was intitled to the wardſhip of the heir, and was called the *guardian in chivalry*. This wardſhip conſiſted in having the cuſtody of the body and lands of ſuch heir, without any account of the profits, till the age of 21 in males, and 16 in females. For the law ſuppoſed the heir-male unable to perform knight-ſervice till 21; but as for the female, ſhe was ſuppoſed capable at 14 to marry, and then her huſband might perform the ſervice. The lord therefore had no wardſhip, if at the death of the anceſtor the heir-male was of the full age of 21, or the heir-female of 14: yet if ſhe was then under 14, and the lord once had her in ward, he might keep her ſo till 16, by virtue of the ſtatute of Weſtminſter, 1. 3 Edw. I. c. 22. the two additional years being given by the legiſlature for no other reaſon but merely to benefit the lord.

This wardſhip, ſo far as it related to land, though it was not nor could be part of the law of feuds, ſo long as they were arbitrary, temporary, or for life only; yet when they became hereditary, and did conſequently often deſcend upon infants, who by reaſon of their age could neither perform nor ſtipulate for the ſervices of the feud, does not ſeem upon feodal principles to have been unreaſonable. For the wardſhip of the land, or cuſtody of the feud, was retained by the lord, that he might out of the profits thereof provide a fit perſon to ſupply the infant's ſervices till he ſhould be of age to perform them himſelf. And if we conſider a feud in its original import, as a ſtipend, fee, or reward for actual ſervice, it could not be thought hard that the lord ſhould withhold the ſtipend ſo long as the ſervice was ſuſpended. Though undoubtedly to our Engliſh anceſtors, where ſuch ſtipendary donation was a mere ſuppoſition or figment, it carried abundance of hardſhip; and accordingly it was relieved by the charter of Henry I. which took this cuſtody from the lord, and ordained that the cuſtody, both of the land and the children, ſhould belong to the widow or next of kin. But this noble immunity did not continue many years.

The wardſhip of the body was a conſequence of the wardſhip of the land; for he who enjoyed the infant's eſtate was the propereſt perſon to educate and maintain him in his infancy: and alſo, in a political view, the lord was moſt concerned to give his tenant a ſuitable education, in order to qualify him the better to perform thoſe ſervices which in his maturity he was bound to render.

When the male heir arrived at the age of 21, or the heir-female at that of 16, they might ſue out their livery or *ouſterlemain*; that is, the delivery of their lands out of their guardian's hands. For this they were obliged to pay a fine, namely, half-a-year's profits of the land; though this ſeems expreſsly contrary to *magna charta*. However, in conſideration of their lands having been ſo long in ward, they were excuſed all reliefs, and the king's tenants alſo all primer ſeiſins. In order to aſcertain the profits that aroſe to the crown by theſe fruits of tenure, and to grant the heir his livery, the itinerant juſtices, or juſtices in eyre, had it formerly in charge to make inquiſition concerning them by a jury of the county, commonly called an *inquiſitio poſt mortem;* which was inſtituted to inquire (at the death of any man of fortune) the value of his eſtate, the tenure by which it was holden, and who, and of what age, his heir was; thereby to aſcertain the relief and value of the primer ſeiſin, or the wardſhip and livery accruing to the king thereupon. A manner of proceeding that came in proceſs of time to be greatly abuſed, and at length an intolerable grievance; it being one of the principal accuſations againſt Empſon and Dudley, the wicked engines of Henry VII. that by colour of falſe inquiſitions they compelled many perſons to ſue out livery from the crown, who by no means were tenants thereunto. And afterwards a court of wards and liveries was erected, for conducting the ſame inquiries in a more ſolemn and legal manner.

When the heir thus came of full age, provided he held a knight's fee, he was to receive the order of knighthood, and was compellable to take it upon him, or elſe pay a fine to the king. For in thoſe heroical times no perſon was qualified for deeds of arms and chivalry who had not received this order, which was conferred with much preparation and ſolemnity. We may plainly diſcover the footſteps of a ſimilar cuſtom in what Tacitus relates of the Germans, who, in order to qualify their young men to bear arms, preſented them in a full aſſembly with a ſhield and lance; which ceremony is ſuppoſed to have been the original of the feodal knighthood. This prerogative, of compelling the vaſſals to be knighted, or to pay a fine, was expreſsly recogniſed in parliament by the ſtatute *de militibus*, 1 Edw. II.; was exerted as an expedient for raiſing money by many of our beſt princes, particularly by Edw. VI. and Queen Elizabeth; but this was the occaſion of heavy murmurs when exerted by Charles I.: among whoſe many misfortunes it was, that neither himſelf nor his people ſeemed able to diſtinguiſh between the arbitrary ſtretch and the legal exertion of prerogative. However, among the other conceſſions made by that unhappy prince before the fatal recourſe to arms, he agreed to diveſt himſelf of this undoubted flower of the crown; and it was accordingly aboliſhed by ſtatute 16 Car. I. c. 20.

WARE, a town of Hertfordſhire, with a market on Tueſdays, and a fair on the laſt Tueſday in April, and Tueſday before St Matthew's day (Sep. 21.) for horſes and other cattle. It is a large, well frequented, and well inhabited thoroughfare town, ſeated on the river Lea, 21 miles north of London. It carries on a great trade in malt and corn, which they are continually ſending in large quantities to London. E. Long. 0. 3. N. Lat. 51. 50.

WARN, in *Law*, is to ſummon a perſon to appear in a court of juſtice.

WARNING *of TENANTS*, in *Scots Law*. See LAW, N° clxvii. 16.

WARP, in the manufactures, a name for the threads, whether of ſilk, wool, linen, hemp, &c. that are extended lengthwiſe on the weaver's loom; and acroſs which the workman, by means of his ſhuttle paſſes the threads of the woof, to form a cloth, ribband, fuſtian, or the like.

WARP, a ſmall rope employed occaſionally to remove a ſhip from one place to another, in a port, road, or river. And hence,

To WARP, is to change the ſituation of a ſhip, by pulling her from one part of a harbour, &c. to ſome other, by means of warps, which are attached to buoys; to anchors ſunk in the bottom; or to certain ſtations upon the ſhore, as poſts, rings, trees, &c. The ſhip is accordingly drawn forwards to thoſe ſtations, either by pulling on the warps by hand, or by the application of ſome purchaſe, as a tackle, windlaſs, or capſtern, upon her deck.

When this operation is performed by the ſhip's leſſer anchors, theſe machines, together with their warps, are carried out in the boats alternately towards the place where the ſhip is endeavouring to arrive: ſo that when ſhe is drawn up cloſe to one anchor, the other is carried out to a competent diſtance before her, and being ſunk, ſerves to fix the other warp, by which ſhe is farther advanced.

Warping is generally uſed when the ſails are unbent, or when they cannot be ſucceſsfully employed, which may either ariſe from the unfavourable ſtate of the wind, the oppoſition of the tide, or the narrow limits of the channel.

WARRANDICE, in *Scots Law*. See LAW, N° clxiv. 11.

WARRANT, is a power and charge to a conſtable or other officer to apprehend a perſon accuſed of any crime. It may be iſſued in extraordinary caſes by the privy council, or ſecretaries of ſtate; but moſt commonly it is iſſued by juſtices of the peace. This they may do in any caſes where they have a juriſdiction over the offence, in order to compel the perſon accuſed to appear before them; for it would be abſurd to give them power to examine an offender, unleſs they had alſo power to compel him to attend and ſubmit to ſuch examination. And this extends to all treaſons, felonies, and breaches of the peace; and alſo to all ſuch offences as they have power to puniſh by ſtatute. Before the granting of the warrant, it is fitting to examine upon oath the party requiring it, as well to aſcertain that there is a felony or other crime actually committed, without which no warrant ſhould be granted; as alſo to prove the cauſe and probability of ſuſpecting the party againſt whom the warrant is prayed.

Blackſt. Comment. vol. iv. p. 290.

This warrant ought to be under the hand and ſeal of the juſtice; ſhould ſet forth the time and place of making, and the cauſe for which it is made; and ſhould be directed to the conſtable, or other peace officer, or it may be to any private perſon by name. A general warrant to apprehend all perſons ſuſpected, without naming or particularly deſcribing any perſon in ſpecial, is illegal and void for its uncertainty; for it is the duty of the magiſtrate, and ought not to be left to the officer, to judge of the ground of ſuſpicion. Alſo a warrant to apprehend all perſons guilty of ſuch a crime, is no legal warrant; for the point upon which its authority reſts, is a fact to be decided on a ſubſequent trial; namely, whether the perſon apprehended thereupon be guilty or not guilty. When a warrant is received by the officer, he is bound to execute it, ſo far as the juriſdiction of the magiſtrate and himſelf extends. A warrant from any of the juſtices of the court of king's bench extends over all the kingdom, and is teſted or dated *England*: but a warrant of a juſtice of the peace in one county, muſt be backed, that is, ſigned, by a juſtice of another county, before it can be executed there. And a warrant for apprehending an Engliſh or a Scotch offender, may be indorſed in the oppoſite kingdom, and the offender carried back to that part of the united kingdom in which the offence was committed.

WARRANTY, WARRANTIA, in *Law*, a promiſe, or covenant, by deed, made by the bargainer for himſelf and his heirs, to warrant and ſecure the bargainee and his heirs, againſt all men, for enjoying the thing agreed on or granted between them.

WARREN, SIR PETER, an admiral, diſtinguiſhed by his virtue, learning, and undaunted courage, was deſcended from an ancient family in Ireland, and received a ſuitable education to qualify him for a command in the royal navy, in which he ſerved for ſeveral years with great reputation; but the tranſaction which placed his great abilities in their full light, was the taking of Louiſbourg in the year 1745, when he was appointed commodore of the Britiſh ſquadron ſent on that ſervice. He joined the fleet of tranſports from Boſton in Canſo bay on the 25th of April, having under his command the Superb of 60, and the Launceſton and Eltham of 40 guns; he was afterwards joined by ſeveral other men of war ſent from England, and took poſſeſſion of Louiſbourg on the 17th of June. The French, exaſperated at this loſs, were conſtantly on the watch to retake it; and in 1747 fitted out a large fleet for that purpoſe, and at the ſame time another ſquadron to proſecute their ſucceſs in the Eaſt Indies. Theſe ſquadrons failed at the ſame time; but the views of the French were rendered abortive by the gallant admiral Anſon and Sir Peter Warren, who had been created rear-admiral, who with a large fleet of ſhips fell in with the French, defeated the whole fleet, and took the greateſt part of the men of war. This was the laſt ſervice Sir Peter rendered to his country as a commander in the Britiſh fleet; for a peace being concluded in the ſucceeding year, the fleet was laid up in the ſeveral harbours.

He was now choſen one of the repreſentatives in parliament for Weſtminſter; and in the midſt of his popularity he paid a viſit to Ireland, his native country, where he died of an inflammatory fever in 1752, ſincerely lamented by all ranks of people; and an elegant monument of white marble was erected to his memory in Weſtminſter abbey.

WARREN, is a franchiſe or place privileged by preſcription or grant from the king, for the keeping of beaſts and fowls of the warren; which are hares and coneys, partridges, pheaſants, and ſome add quails, woodcocks, and water-fowl, &c. Theſe being *feræ naturæ*, every one had a natural right to kill as he could: but upon the introduction of the foreſt laws at the Norman conqueſt, theſe animals being looked upon as royal game, and the ſole property of our ſavage monarchs, this franchiſe of free-warren was invented to protect them, by giving the grantee a ſole and excluſive power of killing ſuch game, ſo far as his warren extended, on condition of his preventing other perſons. A man therefore that has the franchiſe of warren, is in reality no more than a royal game-keeper: but no man, not even a lord of a manor, could by common law juſtify ſporting on another's ſoil, or even on his own, unleſs he had the liberty of free-warren. This franchiſe is almoſt fallen into diſregard ſince the new ſtatutes for preſerving the game; the name being now chiefly preſerved in grounds that are ſet apart for breeding hares and rabbits. There are many inſtances of keen ſportſmen in ancient times, who have ſold their eſtates, and reſerved the free-warren, or right of killing game, to themſelves: by which means it comes to paſs that a man and his heirs have ſometimes free-warren over another's ground.

A warren may lie open; and there is no neceſſity of incloſing it as there is of a park. If any perſon offend in a free-warren, he is puniſhable by the common law, and by ſtatute 21 Edw. III. And if any one enter wrongfully into any warren, and chaſe, take, or kill, any coneys without the conſent of the owner, he ſhall forfeit treble damages, and ſuffer three months impriſonment, &c. by 22 and 23 Car. II. c. 25. When coneys are on the ſoil of the party, he hath a property in them by reaſon of the poſſeſſion, and action lies for killing them; but if they run out of the warren and eat up a neighbour's corn, the owner of the land may kill them, and no action will lie.

WARSAW, a large city of Poland, the capital of that country, and of the province of Maſovia. It is built partly in a plain, and partly on a gentle aſcent riſing from the banks of the Viſtula, which is about as broad as the Thames at Weſtminſter, but very ſhallow in ſummer. This city and its ſuburbs occupy a vaſt extent of ground, and are ſuppoſed to contain 70,000 inhabitants, among whom is a great number of foreigners. The whole has a melancholy appearance, exhibiting the ſtrong contraſt of wealth and poverty, luxury and diſtreſs, which pervades every part of this unhappy country. The ſtreets are ſpacious, but ill paved; the churches and public buildings are large and magnificent; the palaces of the nobility are numerous and ſplendid; but the greateſt part of the houſes, particularly in the ſuburbs, are mean and ill-conſtructed wooden hovels.—Warſaw is 160 miles ſouth-eaſt by ſouth of Dantzic, 130 north-north-eaſt of Cracow, and 300 north-eaſt by north of Vienna. E. Long. 21. 6. N. Lat. 50. 14.

WART. See SURGERY *Index*.

WARWICK, the capital of Warwickſhire in England, and from which this county derives its name. It is very ancient, and ſuppoſed by Camden to be the place called by the Romans *Præſidium*, where the Dalmatian horſe were poſted. It ſtands on a rock of freeſtone, of which all the public edifices in the town are built. At the Norman invaſion it was a conſiderable place; and had many burgeſſes, of whom 12 were obliged by their tenure to accompany the king in his wars. It is ſupplied with water brought in pipes from ſprings half a mile from the town, beſides what it derives from the wells within it made in the rock: and it is eaſily kept clean, by being ſituated upon a declivity. Four ſtreets, from the four cardinal points of the compaſs, meet in the centre of the town. The principal public buildings are

St Mary's, a very ſtately edifice, an hoſpital, a town-houſe of freeſtone, three charity ſchools, and a noble bridge over the Avon. It has had ſeveral charters; but is governed at preſent by a mayor, 12 brethren, 24 burgeſſes, &c. It contains 5775 inhabitants; and gives title of earl to the family of the Grevilles. W. Long. 1. 36. N. Lat. 52. 20.

WARWICKSHIRE, a county of England, 47 miles in length, by 30 in breadth. It is bounded at its northern extremity by a point of Derbyſhire; on the north-weſt by Staffordſhire; on the north-eaſt by Leiceſterſhire; on the eaſt by Northamptonſhire; on the ſouth-weſt by Glouceſterſhire, and on the ſouth-eaſt by Oxfordſhire. It is ſituated partly in the dioceſe of Lichfield and Coventry, and partly in that of Worceſter; it contains four hundreds, and one liberty, one city, 12 market towns, 158 pariſhes; ſends ſix members to parliament, and the population is computed at 208,190. The air is mild, pleaſant, and healthy. The river Avon divides the north part of it, or the Woodlands, from the ſouth, called the Feldon; and the ſoil of both is rich and fertile. Its productions are corn, malt, wood, wool, cheeſe, coal, iron, and limeſtone. The chief rivers of this county are the Avon, Tame, and Arrow. Warwick is the capital; but Birmingham is far ſuperior to it in reſpect of trade and manufactures, and even to any other town in England.

Birmingham, in this county, of which the account given in the order of the alphabet is very deficient, is one of the moſt remarkable towns in England, or perhaps in Europe, for the extent, variety, elegance, and utility of its manufactures. This town was little diſtinguiſhed previous to the reign of Charles II. but ſince that period it continued to increaſe in extent and importance. In the year 1700, the number of ſtreets in Birmingham was only 30; they are now nearly 250. In the year 1779 there were only three houſes on a particular ſpot, which in 1791 contained 833.

Birmingham owes its proſperity and population to its manufactures, which are in a great meaſure the conſequence of its vicinity to coal, aided by the ſpirited and induſtrious exertions of a few individuals. It has been ſtated, and no doubt with great truth, that its proſperity is in no ſmall degree indebted to its exemption from the reſtrictions of borough and corporate laws. To give ſome notion of the progreſs and extent of the manufactures of this place, it may be mentioned that the late Mr Taylor, who introduced gilt buttons, japanned, gilt, and painted ſnuff-boxes, with various articles of manufacture in enamel, died in 1775, at the age of 64, having amaſſed a fortune of 200,000l. In painting ſnuff-boxes at ſo low a rate as one farthing each, one man could gain 3l. 10s. per week. The weekly produce of Mr Taylor's manufacture of buttons amounted to 800l. beſide many other valuable and curious productions.

The manufactory of Meſſrs Boulton and Watt, which for its extent, variety, and importance, ſtands unrivalled in Europe, has been already noticed under the word SOHO. The new coinage of copper, which has been often deſervedly admired, and the re-ſtamped dollars, are the productions of the Soho manufactory. The firſt coining mill was erected at Soho in 1783. It is now ſo much improved, that eight machines driven by the ſteam-engine, are going on at the ſame time. Each of thoſe machines ſtrikes from 70 to 84 pieces of the ſize of a guinea per minute, and hence the whole eight machines work off in one hour between 30,000 and 40,000 coins. The different proceſſes of the machinery are, 1. Rolling the maſſes of copper into ſheets. 2. Rolling them through cylindrical ſteel rollers. 3. Clipping the pieces of copper for the dye. 4. Shaking the coin in bags. 5. Striking both ſides of the coin, and then milling it; after which it is diſplaced, and another is introduced, to be ſubjected to the ſame operation. But the moſt extraordinary contrivance of this ingenious machinery is, that a preciſe account of every coin which paſſes through it is regularly kept, ſo that it is impoſſible to practiſe fraud.

Beſide the branches of induſtry already mentioned, there are manufactories of guns, bayonets, and ſwords, of ſporting guns, of whips, of japan ware, of numerous works in braſs and ſteel, both for ornament and uſe, and at one time of leather to a conſiderable extent.

Birmingham contains a muſeum of natural and artificial curioſities, a handſome theatre, rebuilt ſince 1791, ſeveral churches belonging to the eſtabliſhment, various diſſenting meeting houſes, and a number of charitable eſtabliſhments. In the neighbourhood of Birmingham there are three extenſive breweries; and by means of canals this place has the advantage of eaſy communication with almoſt every part of the kingdom.

WASH, among diſtillers, the fermentable liquor uſed by malt diſtillers. See BREWERY.

WASHING, in *Painting*, is when a deſign, drawn with a pen or crayon, has ſome one colour laid over it with a pencil, as Indian ink, biſtre, or the like, to make it appear the more natural, by adding the ſhadow of prominences, apertures, &c. and by imitating the particular matters whereof the thing is ſuppoſed to conſiſt.

Thus a pale red is employed to imitate brick and tile; a pale Indian blue, to imitate water and ſlate; green, for trees and meadows; ſaffron or French berries, for gold or braſs; and ſeveral colours for marbles.

WASHING of Ores, the purifying an ore of any metal, by means of water, from earths and ſtones, which would otherwiſe render it difficult of fuſion.

WASHINGTON, a city of North America, and now the metropolis of the United States. It is ſeated at the junction of the rivers Potomac and the Eaſtern Branch, extending about four miles up each, including a tract of territory ſcarcely to be exceeded, in point of convenience, ſalubrity, and beauty, by any in the world. This territory, which is called *Columbia*, lies partly in the ſtate of Virginia, and partly in that of Maryland, and was ceded by thoſe two ſtates to the United States of America, and by them eſtabliſhed to be the ſeat of government after the year 1800. It is divided into ſquares or grand diviſions, by ſtreets running due north and ſouth, and eaſt and weſt, which form the ground-work of the plan. However, from the Capitol, the preſident's houſe, and ſome of the important areas in the city, run diagonal ſtreets, from one material object to another, which not only produce a variety of charming proſpects, but remove the inſipid ſameneſs which renders ſome other great cities unpleaſing. The great leading ſtreets are all 160 feet wide, including a pavement of 10 feet, and a gravel walk of 30 feet planted with trees on each ſide, which will leave 80 feet of paved ſtreet for carriages. The reſt of the ſtreets are in general

general 110 feet wide, with a few only 90 feet, except North, South, and Eaſt Capitol Streets, which are 160 feet. The diagonal ſtreets are named after the reſpective ſtates compoſing the Union, while thoſe running north and ſouth are, from the Capitol eaſtward, named *Eaſt Firſt Street*, *Eaſt Second Street*, &c. and thoſe weſt of it are in the ſame manner called *Weſt Firſt Street*, *Weſt Second Street*, &c. Thoſe running eaſt and weſt are from the Capitol northward named *North A Street*, *North B Street*, &c. and thoſe ſouth of it are called *South A Street*, *South B Street*, &c. The ſquares or diviſions of the city amount to 1150. The rectangular ſquares generally contain from three to ſix acres, and are divided into lots of from 40 to 80 feet in front, and their depth from about 110 to 300 feet, according to the ſize of the ſquare. The irregular diviſions produced by the diagonal ſtreets are ſome of them ſmall, but generally in valuable ſituations. Their acute points are all to be cut off at 40 feet, ſo that no houſe in the city will have an acute corner. All the houſes muſt be of brick or ſtone. The area for the Capitol (or houſe for the legiſlative bodies) is ſituated upon the moſt beautiful eminence in the city, about a mile from the Eaſtern Branch, and not much more from the Potomac, commanding a full view of every part of the city, as well as a conſiderable extent of the country around. The preſident's houſe will ſtand upon a riſing ground, not far from the banks of the Potomac, poſſeſſing a delightful water proſpect, with a commanding view of the Capitol, and ſome other material parts of the city.

The city being ſituated upon the great poſt road, exactly equidiſtant from the northern and ſouthern extremities of the Union, and nearly ſo from the Atlantic ocean to the river Ohio, upon the beſt navigation, and in the midſt of the richeſt commercial territory in America, commanding the moſt extenſive internal reſources, is by far the moſt eligible ſituation for the reſidence of congreſs; and it is now preſſing forward, by the public-ſpirited enterpriſe, not only of the people of the United States, but alſo of foreigners.

WASHINGTON, *George*, the celebrated commander of the American army, and the firſt preſident of the United States, after their ſeparation from the mother-country, was born in the year 1732, in the pariſh of Waſhington in Virginia. He was deſcended from an ancient family in Cheſhire, of which a branch was eſtabliſhed in Virginia about the middle of the 17th century. Little is known concerning his education, or the early years of his life. Before he was 20 years of age, he was appointed a major in the colonial militia, and had then an opportunity of diſplaying thoſe military and political talents which have ſince rendered his name ſo famous throughout the world. In the diſputes which aroſe between the French and Engliſh officers, about ſettling the limits of Canada and Louiſiana, Major Waſhington was employed by the governor of Virginia as a negociator, and he ſucceeded in preventing a threatened invaſion of the Engliſh frontiers by the French and their Indian allies; but, in the following year, when hoſtilities ſeemed inevitable, he was appointed lieutenant-colonel, and ſoon after to the command of a regiment raiſed by the colony for its own defence. In 1755, Colonel Waſhington ſerved as a volunteer in the unfortunate expedition of General Braddock, and in that expedition, which was attended with great difficulty, he exhibited ſo much calmneſs and intrepidity, that the utmoſt confidence was repoſed in his talents, and perfect obedience paid to his commands by the whole army. After having been employed in a different and more ſucceſsful expedition to the river Ohio, the ſtate of his health required him, about the year 1758, to reſign his military ſituation; and in the ſixteen following years, during which period he married Mrs Cuſtis, a Virginian lady, of amiable character and reſpectable connections, it would appear that he reſided chiefly at his beautiful ſeat of Mount Vernon, and was occupied in the cultivation of his eſtate.

When the diſaffection of the Americans to the Britiſh government had become pretty general, and had at laſt ſpread to the colony of Virginia, Colonel Waſhington was appointed a delegate from that ſtate to the congreſs which met at Philadelphia on the 26th October 1774, and ſoon after he was appointed to the command of the American army, which had aſſembled in the provinces of New England. The conduct of Waſhington during the whole of the war, as well as during the period that he preſided in the government of the United States, has been ſo fully detailed in another part of this work, that it would be unneceſſary repetition, even to give a general outline of it in this place. See AMERICA.

Waſhington reſigned the preſidency in 1796, after having publiſhed a farewell addreſs to his countrymen. This addreſs was remarkably diſtinguiſhed for the ſimplicity and ingenuouſneſs, moderation and ſobriety, the good ſenſe, prudence and honeſty, as well as ſincere affection for his country and for mankind, which the author of it had always exhibited; it ſeemed to be a perfect picture of his whole life. From the time of his reſignation till the month of July 1798, he lived in retirement at his ſeat of Mount Vernon. At this period, when the unprincipled actors in the French revolution were carrying on their wicked machinations in every part of the world to which their influence extended, the United States reſolved to arm by land and ſea in their own defence. General Waſhington was called from his retirement, and the command of the army was beſtowed upon him. This he accepted, becauſe he conſidered, as he himſelf expreſſed it, "every thing we hold dear and ſacred was ſeriouſly threatened, although he had flattered himſelf that he had quitted for ever the boundleſs field of public action, inceſſant trouble, and high reſponſibility, in which he had long acted ſo conſpicuous a part." In this ſituation he continued during the remaining ſhort period of his life. On Thurſday the 12th of December 1799, he was ſeized with an inflammation in the throat, and was carried off on Saturday the 14th of the ſame month, in the 68th year of his age. In his dying moments he diſplayed the ſame calmneſs, ſimplicity, and regularity, which had uniformly marked his conduct through life. He ſaw the approaches of death without fear; and he met them without parade. Even the perfectly well ordered ſtate of the minuteſt particulars of his private buſineſs bear the ſtamp of that conſtant authority of prudence and practical reaſon over his actions which was always the moſt prominent feature of his character.

WASHINGTON is the name of many counties, towns, and villages in the American ſtates; a circumſtance which affords a ſtriking proof in what degree of eſteem and veneration the name from which they are derived was held by the inhabitants of the new world.

WASP. See VESPA, ENTOMOLOGY *Index*.

WATCH, in the art of war, a number of men poſted at any paſſage, or a company of the guards who go on the patrole.

WATCH, in the navy, the ſpace of time wherein one diviſion of a ſhip's crew remains upon deck, to perform the neceſſary ſervices, whilſt the reſt are relieved from duty, either when the veſſel is under ſail or at anchor.

The length of the ſea-watch is not equal in the ſhipping of different nations. It is always kept four hours by our Britiſh ſeamen, if we except the dog-watch, between four and eight in the evening, that contains two reliefs, each of which are only two hours on deck. The intent of this is to change the period of the night-watch every 24 hours; ſo that the party watching from eight till 12 in one night, ſhall watch from midnight till four in the morning on the ſucceeding one. In France the duration of the watch is extremely different, being in ſome places ſix hours, and in others ſeven or eight; and in Turkey and Barbary it is uſually five or ſix hours.

A ſhip's company is uſually claſſed into two parties; one of which is called the *ſtarboard* and the other the *larboard* watch. It is, however, occaſionally ſeparated into three diviſions, as in a road or in particular voyages.

In a ſhip of war the watch is generally commanded by a lieutenant, and in merchant-ſhips by one of the mates; ſo that if there are four mates in the latter, there are two in each watch; the firſt and third being in the larboard, and the ſecond and fourth in the ſtarboard watch: but in the navy, the officers who command the watch uſually divide themſelves into three parties, in order to lighten their duty.

WATCH, is alſo uſed for a ſmall portable movement, or machine, for the meaſuring of time; having its motion regulated by a ſpiral ſpring.

Watches, ſtrictly taken, are all ſuch movements as ſhow the parts of time; as clocks are ſuch as publiſh it, by ſtriking on a bell, &c. But commonly the name *watch* is appropriated to ſuch as are carried in the pocket; and *clock* to the large movements, whether they ſtrike the hour or not. See CLOCK.

The invention of ſpring or pocket-watches belongs to the preſent age. It is true, we find mention made of a watch preſented to Charles V. in the hiſtory of that prince: but this, in all probability, was no more than a kind of clock to be ſet on a table, ſome reſemblance whereof we have ſtill remaining in the ancient pieces made before the year 1670. There was alſo a ſtory of a watch having been diſcovered in Scotland belonging to King Robert Bruce; but this we believe has turned out altogether apocryphal. The glory of this very uſeful invention lies between Dr Hooke and M. Huyghens; but to which of them it properly belongs, has been greatly diſputed; the Engliſh aſcribing it to the former, and the French, Dutch, &c. to the latter. Mr Derham, in his Artificial Clockmaker, ſays roundly, that Dr Hooke was the inventor; and adds, that he contrived various ways of regulation. One way was with a loadſtone: Another with a tender ſtraight ſpring, one end whereof played backwards and forwards with the balance; ſo that the balance was to the ſpring as the bob to a pendulum, and the ſpring as the rod thereof: A third method was with two balances, of which there were divers ſorts; ſome having a ſpiral ſpring to the balance for a regulator, and others without. But the way that prevailed, and which continues in mode, was with one balance, and one ſpring running round the upper part of the verge thereof: Though this has a diſadvantage, which thoſe with two ſprings, &c. were free from; in that a ſudden jerk, or confuſed ſhake, will alter its vibrations, and put it in an unuſual hurry.

The time of theſe inventions was about the year 1658; as appears, among other evidences, from an inſcription on one of the double balance watches preſented to King Charles II. viz. Rob. Hooke *inven.* 1658. T. Tompion *fecit*, 1675. The invention preſently got into reputation, both at home and abroad; and two of them were ſent for by the dauphin of France. Soon after this, M. Huygen's watch with a ſpiral ſpring got abroad, and made a great noiſe in England, as if the longitude could be found by it. It is certain, however, that his invention was later than the year 1673, when his book *de Horol. Oſcillat.* was publiſhed; wherein he has not one word of this, though he has of ſeveral other contrivances in the ſame way.

One of theſe the lord Brouncker ſent for out of France, where M. Huygens had got a patent for them. This watch agreed with Dr Hooke's in the application of the ſpring to the balance; only M. Huygens's had a longer ſpiral ſpring, and the pulſes and beats were much ſlower. The balance, inſtead of turning quite round, as Dr Hooke's, turns ſeveral rounds every vibration.

Mr Derham ſuggeſts, that he has reaſon to doubt M. Huygens's fancy firſt was ſet to work by ſome intelligence he might have of Dr Hooke's invention from Mr Oldenburgh, or ſome other of his correſpondents in England; and this, notwithſtanding Mr Oldenburgh's attempt to vindicate himſelf in the Philoſophical Tranſactions, appears to be the truth. Huygens invented divers other kinds of watches, ſome of them without any ſtring or chain at all; which he called, particularly, *pendulum watches*.

Striking WATCHES are ſuch as, beſides the proper watch-part for meaſuring of time, have a clock-part for ſtriking the hours, &c.

Repeating WATCHES, are ſuch as by pulling a ſtring, &c. repeat the hour, quarter, or minute, at any time of the day or night.—This repetition was the invention of Mr Barlow, and firſt put in practice by him in larger movements or clocks about the year 1676. The contrivance immediately ſet the other artiſts to work, who ſoon contrived divers ways of effecting the ſame. But its application to pocket-watches was not known before King James II.'s reign; when the ingenious inventor above mentioned, having directed Mr Thompſon to make a repeating watch, was ſoliciting a patent for the ſame. The talk of a patent engaged Mr Quare to reſume the thoughts of a like contrivance, which he had had in view ſome years before: he now effected it; and being preſſed to endeavour to prevent Mr Barlow's patent, a watch of each kind was produced before the king and council; upon trial of which, the preference was given to Mr Quare's. The difference between them was, that Barlow's was made to repeat by puſhing in two pieces on each ſide the watch-box; one of which repeated the hour, and the other the quarter: whereas Quare's was made to repeat by a pin that ſtuck out near the pendant, which being thruſt in (as

now

now it is done by thruſting in the pendant itſelf), repeated both the hour and quarter with the ſame thruſt.

Plate DLXXI. Fig. 1. Fig. 2.

Of the Mechaniſm of a WATCH, properly ſo called. Watches, as well as clocks, are compoſed of wheels and pinions, and a regulator to direct the quickneſs or ſlowneſs of the wheels, and of a ſpring which communicates motion to the whole machine. But the regulator and ſpring of a watch are vaſtly inferior to the weight and pendulum of a clock, neither of which can be employed in watches. In place of a pendulum, therefore, we are obliged to uſe a balance (fig. 1.) to regulate the motion of a watch; and a ſpring (fig. 2.) which ſerves in place of a weight, to give motion to the wheels and balance.

Fig. 3. Fig. 4. Fig. 5.

The wheels of a watch, like thoſe of a clock, are placed in a frame formed of two plates and four pillars. Fig. 3. repreſents the inſide of a watch, after the plate (fig. 4.) is taken off. A is the barrel which contains the ſpring (fig. 2.); the chain is rolled about the barrel, with one end of it fixed to the barrel A (fig. 5.), and the other to the fuſee B.

Fig. 6. Fig. 7. Fig. 8.

When a watch is wound up, the chain which was upon the barrel winds about the fuſee, and by this means the ſpring is ſtretched; for the interior end of the ſpring is fixed by a hook to the immoveable axis, about which the barrel revolves; the exterior end of the ſpring is fixed to the inſide of the barrel, which turns upon an axis. It is therefore eaſy to perceive how the ſpring extends itſelf, and how its elaſticity forces the barrel to turn round, and conſequently obliges the chain which is upon the fuſee to unfold and turn the fuſee; the motion of the fuſee is communicated to the wheel C (fig. 5.); then, by means of the teeth, to the pinion *c*, which carries the wheel D; then to the piſton *d*, which carries the wheel E; then to the pinion *e*, which carries the wheel F; then to the pinion *f*, upon which is the balance-wheel G, whoſe pivot runs in the pieces A called the *potance*, and B called a *follower*, which are fixed on the plate fig. 4. This plate, of which only a part is repreſented, is applied to that of fig. 3. in ſuch a manner that the pivots of the wheels enter into holes made in the plate fig. 3. Thus the impreſſed force of the ſpring is communicated to the wheels: and the pinion *f* being then connected to the wheel F, obliges it to turn (fig. 5.). This wheel acts upon the palettes of the verge, 1, 2, (fig. 1.), the axis of which carries the balance HH, (fig. 1.). The pivot I, in the end of the verge, enters into the hole *c* in the potance A (fig. 4.). In this figure the palettes are repreſented; but the balance is on the other ſide of the plate, as may be ſeen in fig. 6. The pivot 3 of the balance enters into a hole of the cock BC (fig. 7.), a perſpective view of which is repreſented in fig. 8. Thus the balance turns between the cock and the potance *c* (fig. 4.), as in a kind of cage. The action of the balance-wheel upon the palettes 1, 2 (fig. 1.), is the ſame with what we have deſcribed with regard to the ſame wheel in the clock; *i. e.* in a watch, the balance-wheel obliges the balance to vibrate backwards and forwards like a pendulum. At each vibration of the balance a palette allows a tooth of the balance-wheel to eſcape; ſo that the quickneſs of the motion of the wheels is entirely determined by the quickneſs of the vibrations of the balance; and theſe vibrations of the balance and motion of the wheels are produced by the action of the ſpring.

Fig. 9.

But the quickneſs or ſlowneſs of the vibrations of the balance depend not ſolely upon the action of the great ſpring, but chiefly upon the action of the ſpring *a*, *b*, *c*, called *the ſpiral ſpring* (fig. 9.), ſituated under the balance H, and repreſented in perſpective (fig. 6.). The exterior end of the ſpiral is fixed to the pin *a*, (fig. 9.) This pin is applied near the plate in *a*, (fig. 6.); the interior end of the ſpiral is fixed by a peg to the centre of the balance. Hence if the balance is turned upon itſelf, the plates remaining immoveable, the ſpring will extend itſelf, and make the balance perform one revolution. Now, after the ſpiral is thus extended, if the balance be left to itſelf, the elaſticity of the ſpiral will bring back the balance, and in this manner the alternate vibrations of the balance are produced.

In fig. 5. all the wheels above deſcribed are repreſented in ſuch a manner, that you may eaſily perceive at firſt ſight how the motion is communicated from the barrel to the balance.

Fig. 10. Fig. 11.

In fig. 10. are repreſented the wheels under the dial-plate by which the hands are moved. The pinion *a* is adjuſted to the force of the prolonged pivot of the wheel D (fig. 5.), and is called a *cannon pinion*. This wheel revolves in an hour. The end of the axis of the pinion *a*, upon which the minute-hand is fixed, is ſquare; the pinion (fig. 10.) is indented into the wheel *b*, which is carried by the pinion *a*. Fig. 11. is a wheel fixed upon a barrel, into the cavity of which the pinion *a* enters, and upon which it turns freely. This wheel revolves in 12 hours, and carries along with it the hour-hand. For a full account of the principles upon which watches and all time-keepers are conſtructed, we muſt refer our readers to a ſhort treatiſe, entitled *Thoughts on the Means of improving Watches*, by Thomas Mudge.

WATCH-Glaſſes, in a ſhip, are glaſſes employed to meaſure the period of the watch, or to divide it into any number of equal parts, as hours, half-hours, &c. ſo that the ſeveral ſtations therein may be regularly kept and relieved, as at the helm, pump, look-out, &c.

WATCH-Work. There is one part of the movements of clocks and watches of which we have yet given no particular account. This is the method of applying the maintaining power of the wheels to the regulator of the motions, ſo as not to injure its power of regulation. This part of the conſtruction is called SCAPEMENT, and falls to be deſcribed under the preſent article, to which we have referred from SCAPEMENT.

1 Objects of ſcapements.

The motions of a clock or watch are regulated by a pendulum or balance, without which check the wheels impelled by the weight in the clock, or ſpring in the watch, would run round with a rapidly accelerating motion, till this ſhould be rendered uniform by friction, and the reſiſtance of the air. If, however, a pendulum or balance be put in the way of this motion, in ſuch a manner that only one tooth of a wheel can paſs, the revolution of the wheels will depend on the vibration of the pendulum or balance.

We cannot here enter on an hiſtorical account of the improvements that have been made on the regulating powers of clocks and watches, nor can we detail the principles on which their action depends. It will be ſufficient here to notice the moſt ſimple conſtruction of ſcapements, and then to deſcribe two or three of the moſt improved conſtructions that have been applied to time-keepers.

We know that the motion of a pendulum or balance is alternate, while the preſſure of the wheels is conſtantly exerted in the ſame direction. Hence it is evident that ſome means muſt be employed to accommodate theſe different motions to each other. Now, when a tooth of the wheel has given the pendulum or balance a motion in one direction, it muſt quit it, that the pendulum or balance may receive an impulſion in the oppoſite direction. This *eſcaping* of the tooth has given riſe to the term *ſcapement*.

2 Beſt ordinary ſcapement for clocks. Fig. 12. The ordinary ſcapement is extremely ſimple, and may be thus illuſtrated. Let *x y* fig. 12. Plate DLXXI. repreſent a horizontal axis, to which the pendulum *p* is attached by a ſlender rod. This axis has two leaves *c* and *d*, one near each end, and not in the ſame plane, but ſo that when the pendulum hangs perpendicularly at reſt, *c* ſpreads a few degrees to the right, and *d* as much to the left. Theſe are called the pallets. Let *a f b* repreſent a wheel, turning on a perpendicular axis *e o* in the order *a f e b*. The teeth of this wheel are in the form of thoſe of a ſaw, leaning forward in the direction of the rim's motion. This wheel is uſually called the crown-wheel, or in watches the balance-wheel. See CLOCK and WATCH. It generally contains an odd number of teeth. In the figure the pendulum is repreſented at the extremity of its excurſion towards the right, the tooth *a* having juſt eſcaped from the pallet *c*, and *b* having juſt dropt on *d*. Now it is evident that while the pendulum is moving to the left, in the arch *p g*, the tooth *b* ſtill preſſes on the pallet *d*, and thus accelerates the pendulum, both in its deſcent along *p h*, and its aſcent up *h g*, and that when *d*, by turning round the axis *x y*, raiſes its point above the plane of the wheel, the tooth *b* eſcapes from it, and *i* drops on *c*, now nearly perpendicular. Thus *c* is preſſed to the right, and the motion of the pendulum along *g p*, is accelerated. Again, while the pendulum hangs perpendicularly in the line *x h*, the tooth *b*, by preſſing on *d*, will force the pendulum to the left, in proportion to its lightneſs, and if it be not too heavy, will force it ſo far from the perpendicular, that *b* will eſcape, and *i* will catch on *c*, and force the pendulum back to *p*, when the ſame motion will be repeated. This effect will be more remarkable, if the rod of the pendulum be continued through *x y*, and have a ball *q* on the other end, to balance *p*. When *b* eſcapes from *d*, the balls are moving with a certain velocity and momentum, and in this condition the balance is checked when *i* catches on *c*. It is not, however, inſtantly ſtopped, but continues to move a little to the left, and *i* is forced a little backward by the pallet *c*. It cannot make its eſcape over the top of the tooth *i*, as all the momentum of the balance was generated by the force of *b*, and *i* is of equal power. Beſides, when *i* catches on *c*, and the motion of *c* to the left continues, the lower point of *c* is applied to the face of *i*, which now acts on the balance by a long lever, ſoon ſtops its motion in that direction, and continuing to preſs on *c*, urges the balance in the oppoſite direction. It is eaſy to ſee that the motion of the wheel here muſt be hobbling and unequal, which has given to this ſcapement the name of the *recoiling* ſcapement.

3 Vibrations of pendulums are iſochronous. In conſidering the utility of the following improved ſcapement for clocks, we muſt keep in mind the following propoſition, which, after the above illuſtration, ſcarcely requires any direct proof. It is, that the natural vibrations of a pendulum are *iſochronous*, or are performed in equal times. The great object of the ſcapement is to preſerve this iſochronous motion of the pendulum.

4 Cumming's ſcapement for clocks. Fig. 13. As the defect of the recoiling ſcapement was long apparent, ſeveral ingenious artiſts attempted to ſubſtitute in its place a ſcapement that ſhould produce a more regular and uniform motion. Of theſe, the ſcapement contrived by Mr Cumming appears to be one of the moſt ingenious in its conſtruction, and moſt perfect in its operation. The following conſtruction is ſimilar to that of Mr Cumming but rendered rather leſs complex for the purpoſe of ſhortening the deſcription.

Let A B C, fig. 13. repreſent a portion of the ſwing wheel, of which O is the centre, and A one of the teeth; Z is the centre of the crutch, pallets, and pendulum. The crutch is repreſented of the form of the letter A, having in the circular croſs piece a ſlit *i k*, alſo circular, Z being the centre. The arm Z F forms the firſt detent, and the tooth A is repreſented as locked on it at F. D is the firſt pallet on the end of the arm Z *d* moveable round the ſame centre with the detents, but independent of them. The arm *d e* to which the pallet D is attached, lies wholly behind the arm Z F of the detent, being fixed to a round piece of braſs *e f g*, having pivots turning concentric with the axis of the pendulum. To the ſame piece of braſs is fixed the horizontal arm *e* H, carrying at its extremity the ball H, of ſuch ſize, that the action of the tooth A on the pallet D is juſt able to raiſe it up to the poſition here drawn. Z P *p* repreſents the fork, or pendulum rod, behind both detent and pallet. A pin *p* projects forward, coming through the ſlit *i k*, without touching either margin of it. Attached to the fork is the arm *m n*, of ſuch length that, when the pendulum rod is perpendicular, the angular diſtance of *n q* from the rod *e q* H is juſt equal to the angular diſtance of the left ſide of the pin *p* from the left end *i* of the ſlit *i k*.

Now, the natural poſition of the pallet D is at δ, repreſented by the dotted lines, reſting on the back of the detent F. It is naturally brought into this poſition by its own weight, and ſtill more by the weight of the ball H. The pallet D, being ſet on the foreſide of the arm at Z, comes into the ſame plane with the detent F and the ſwing-wheel, though here repreſented in a different poſition. The tooth C of the wheel is ſuppoſed to have eſcaped from the ſecond pallet, on which the tooth A immediately ſeizes the pallet D, ſituated at δ, forces it out, and then reſts on the detent F, the pallet D leaning on the tip of the tooth. After the eſcape of C, the pendulum, moving down the arch of ſemivibration, is repreſented as having attained the vertical poſition. Proceeding ſtill to the left, the pin *p* reaches the extremity *i* of the ſlit *i k*; and, at the ſame inſtant, the arm *n* touches the rod *e* H in *q*. The pendulum proceeding a hairſbreadth further, withdraws the detent F from the tooth, which now even puſhes off the detent, by acting on the inclining face of it. The wheel being now unlocked, the tooth following C on the other ſide acts on its pallet, puſhes it off, and reſts on its detent, which has been rapidly brought into a proper poſition by the action of A on the inclining face of F. By a ſimilar action of C on its detent at the moment of eſcape, F was brought into a poſition proper for the wheels being locked by the tooth A. As the pendulum ſtill goes on, the ball H, and pallet connected with it, are carried by the arm *m n*, and before the pin *p* again reaches the

end

end of the ſlit, which had been ſuddenly withdrawn by the action of A on F, the pendulum comes to reſt. It now returns towards the right, loaded with the ball H on the left, and thus the motion loſt during the laſt vibration is reſtored. When the pin *p*, by its motion to the right, reaches the end *k* of *i k*, the wheel on the right ſide is unlocked, and at the ſame inſtant the weight H being raiſed from the pendulum by the action of a tooth like B on the pallet D, ceaſes to act.

In this ſcapement, both pallets and detents are detached from the pendulum, except in the moment of unlocking the wheel, ſo that, except during this ſhort interval, the pendulum may be ſaid to be free during its whole vibration, and of courſe its motion muſt be more equable and undiſturbed.

5 Scapements for watches.

The conſtructing of a proper ſcapement for watches requires peculiar delicacy, owing to the ſmall ſize of the machine, from which the error of $\frac{1}{100}$ of an inch has as much effect as the error of a whole inch in a common clock. From the neceſſary lightneſs of the balance, too, it is extremely difficult to accumulate a ſufficient quantity of regulating power. This can be done only by giving the balance a great velocity, which is effected by concentrating as much as poſſible of its weight in the rim, and making its vibrations very wide. The balance rim of a tolerable watch ſhould paſs through at leaſt ten inches in every ſecond.

6 Vibrations of a balance are iſochronous.

In conſidering the moſt proper ſcapements for watches, we may aſſume the following principle, viz. that the oſcillations of a balance urged by its ſpring, and undiſturbed by extraneous forces, are iſochronous.

7 Beſt ordinary ſcapement for watches. Fig. 14.

In ordinary pocket watches, the common recoiling ſcapement of clocks is ſtill employed, and anſwers the common purpoſes of a watch tolerably well, ſo that, if properly executed, a good ordinary watch will keep time within a minute in the day. Theſe watches, however, are ſubject to great variation in their rate of going, from any change in the power of the wheels.

The following is conſidered as the beſt conſtruction of the common watch ſcapement, and is repreſented by fig. 14. as it appears when looking ſtraight down on the end of the balance arbor. C marks the centre of the balance and verge; CA repreſents the upper pallet, or that next the balance, and CB the lower pallet; F and D are two teeth of the crown wheel, moving from left to right; E, G, are two teeth in the lower part, moving from right to left. The tooth D appears as having juſt eſcaped from the point of C A, and the tooth E as having juſt come in contact with CB. In practice, the ſcapement ſhould not be quite ſo cloſe, as by a ſmall inequality of the teeth, D might be kept from eſcaping at all. The following are thought the beſt proportions: The diſtance between the front of the teeth (that is, of G, F, E, D), and the axis C of the balance, is $\frac{1}{5}$ of FA, the diſtance between the points of the teeth. The length CA, CB of the pallets is $\frac{3}{5}$ of the ſame degrees, and the front DH or FK of the teeth makes an angle of 25° with the axis of the crown wheel. The ſloping ſide of the tooth muſt be of an epicycloidal form, ſuited to the relative motion of the tooth and pallet.

It appears from theſe proportions, that by the action of the tooth D, the pallet A can *throw out* till it reach *a*, 120° from CL, the line of the crown-wheel axis. To this if we add BCA = 95°, we ſhall have LC *a* = 120°. Again, B will throw out as far on the other ſide. Now, if from 240°, the ſum of the extent of vibration of both pallets, we take 95° the angle of the pallets, the remainder 145° will expreſs the greateſt vibration which the balance can make, without ſtriking the front of the teeth. From ſeveral cauſes, however, this meaſure is too great, and 120° is reckoned a ſufficient vibration in the beſt ordinary ſcapement.

7 Graham's horizontal ſcapement. Fig. 15. and 16.

Of the improvements on the ſcapements of watches, one of the moſt important is that by Mr George Graham, which we ſhall proceed to deſcribe. DE, fig. 15. repreſents part of the rim of the balance wheel; A and C, two of its teeth with their faces *b e* formed into planes, inclined to the circumference of the wheel in an angle of about 15°, ſo that the length *b e* of the face may be nearly quadruple of its height *e m*. Let a circular arch ABC be deſcribed round the centre of the wheel, and through the middle of the faces of the teeth. The axis of the balance will paſs through ſame point B of this arch, and the mean circumference of the teeth may be ſaid to paſs through the centre of the verge. On this axis is fixed a portion of a thin hollow cylinder *b c d*, made of hard tempered ſteel, or of ſome hard and tough ſtone, ſuch as ruby or ſapphire. By this conſtruction the portion of the cylinder occupies 210° of the circumference. The edge *b*, to which the tooth approaches from without, is rounded off on both angles. The other edge *d* is formed into a plane, inclined to the radius about 30°. Now, ſuppoſe the wheel preſſed forward in the direction AC, the point *b* of the tooth, touching the rounded edge, will puſh it outwards, turning round the balance in the direction *b c d*. The heel *e* of the tooth will eſcape from this edge when it is in the poſition *h*, and *e* is in the poſition *f*. The point *b* of the tooth will now be at *d*, but the edge of the cylinder will be at *i*. The tooth therefore reſts in the inſide of the cylinder, while the balance continues its vibration a little way, in conſequence of the impulſe it has received from the action of the inclined plane. When this vibration is ended, by the oppoſition of the balance ſpring, the balance will return, and the tooth now in the poſition B, rubbing on the inſide of the cylinder, the balance comes back into its natural poſition *b c d*, with an accelerated motion by the action of its ſpring, and would of itſelf vibrate as far as the other ſide. It is, however, aſſiſted again by the tooth, which preſſes on the edge *d*, puſhes it aſide till it attain the poſition *k*, when the tooth entirely eſcapes from the cylinder. At this inſtant the other edge of the cylinder, having attained the poſition *l*, is in the way of the next tooth, which is now in the poſition A, while the balance continues its vibration, the tooth reſting and rubbing on the outſide of the cylinder. When this vibration is finiſhed, the balance, by the action of the ſpring, reſumes its firſt motion, and as ſoon as the balance gets into its natural poſition, the tooth begins to act on the edge *b*, puſhes it aſide, eſcapes from it, and drops as before in the inſide of the cylinder. In this conſtruction the arch of action or ſcapement is 30° = twice the angle which the face of a tooth makes with the circumference.

It is neceſſary to explain how the cylinder is connected with the verge, ſo as to make ſuch a great revolution round the tooth of the wheel. The triangular tooth *e b m* is placed on the top of a little pillar fixed into the end of the piece of braſs *m* D formed in the rim of the wheel. Thus the plane of the wedge tooth is parallel

rallel to the plane of the wheel, but at a ſmall diſtance above it. The verge is repreſented at fig. 16, and conſiſts of a long hollow cylinder of hard ſteel, having a great portion of the metal cut out. If ſpread out flat, this cylinder would aſſume the form of fig. 17; and if we conceive this flat piece rolled up till the edges GH, and G′ H′ unite, we ſhall have the exact form. The part acted on by the point of the tooth is denoted by the dotted line *b d*, and the part D, I, F, E, ſerves to connect the two ends.

This ſcapement of Mr Graham is called a *horizontal* ſcapement, becauſe the balance is parallel to the other wheels.

8 Lepaute's improvement.

Fig. 18 & 19.

Another ſcapement of a ſuperior conſtruction was contrived by M. Lepaute of Paris, and is of ſuch a ſingular form as to render it extremely difficult to illuſtrate it by a figure. The repreſentations at fig. 18 and 19 will, however, give general readers ſome idea of its mode of action, and a ſkilful artiſt will eaſily ſee how the ſeveral parts may be adapted to each other. ABC fig. 18. repreſents part of the rim of the balance wheel, having the pins 1, 2, 3, 4, 5, &c. projecting from its faces; the pins 1, 3, 5, being on the ſide next the eye, and the pins 2 and 4 on the oppoſite ſide. D is the centre of the balance and verge, and the ſmall circle round D repreſents its thickneſs. But the verge in this place is crooked, that the rim of the wheel may not be intercepted by it. To it is attached a piece of hard tempered ſteel *a b c d*, of which the part *a b c* is a concave arch of a circle, having D for its centre. It wants about 30° of a ſemicircle. The reſt *c d* is alſo an arch of a circle, having the ſame radius with the balance wheel. In the natural poſition of the balance, a line drawn from D, through the middle of the face *c d*, is a tangent to the circumference of the wheel. But if the balance be turned round till the point *d* of the horn come to *d′*, and the point *c* come to 2, in the circumference in which the pins are placed, the pin preſſing on the beginning of the horn or pallet, puſhes it aſide, ſlides along it, and eſcapes at *d*, having generated a certain velocity in the balance. Let another pallet ſimilar to that now deſcribed be placed on the other ſide of the wheel, but in a contrary poſition, with the acting face of the pallet turned away from the centre of the wheel. Let it be ſo placed at E, that the moment the pin 1 on the upper ſide of the wheel eſcapes from the pallet *c d*, the pin 4 on the lower ſide of the wheel falls on the end of the circular arch *e f g* of the other pallet. Now, if the pallets be connected by equal pulleys G and F on the axis of each, and a thread round both, ſo that they ſhall turn one way; the balance on the axis D, having received an impulſe from the pin 1, will continue its motion from A towards *i*, and will carry the other pallet with a ſimilar motion round the centre E from *h* to *k*. The pin 4 will therefore reſt in the concave arch *g f e* as the pallet turns round. When the force of the balance is ſpent, the pallet *c d* returns towards its firſt poſition. The pallet *g h* turns with it, and when the point of the firſt has arrived at *d*, the beginning *g* of the other arrives at the pin 4; and, proceeding farther, this pin eſcapes from the concave arch *e f g*, and ſlides along the pallet *g h*, puſhing it aſide, and of courſe urging the pallet round the centre E, and the balance on the axis D round at the ſame time, and in the ſame direction. The pin 4 eſcapes from the pallet *g h*, when *h* arrives at 3; but while the pin 4 is ſliding along the yielding pallet *g h*, the pin 3 is moving in the circumference BDA; and the inſtant that the pin 4 eſcapes from *h* at 3, the pin 3 arrives at 2, where the beginning *c* of the concave arch *c b* is ready to receive it. It therefore reſts on this arch, while the balance continues its motion, and this may continue till the point *b* of the arch comes to 2. The balance now ſtops, its force being ſpent, and then returns; and the pin 3 eſcapes from the circle at *c*, ſlides along the yielding pallet *c d*, and when it eſcapes at 1, another pin on the lower ſide of the wheel arrives at 4, and finds the arch *g f e* ready to receive it. And thus the vibration of the balance will be continued.

From the above deſcription we may deduce the proper dimenſions of the parts of the pallet. Thus, the length of the pallet *c d* or *g h*, muſt be equal to the interval between two ſucceeding pins, and the diſtance of the centres DE, muſt be double of that interval. The radius D *e* or E *g*, may be as ſmall as we chooſe. The concave arches *c b a* and *g f e*, muſt be continued ſo far as to allow a pin to reſt on them during the whole excurſion of the balance. The angle of ſcapement, in which the balance remains under the influence of the wheels, is obtained by drawing the lines D *c* and D *d*, and we ſhall find that this angle *c* D *d* is here about 30°, though it may be made either greater or leſs than this.

Fig. 19.

Fig. 19. explains how the two pallets may be combined on one verge. KL is the verge with a pivot at each end. It is bent like a crank MNO, to admit the balance wheel between its branches. BC repreſents this wheel, ſeen edgewiſe, with its pin alternately on different ſides. The pallets are alſo repreſented by *b c d* and *h g f*, ſized to the inſide of the branches of the crank, fronting each other. The poſition of their acting faces may be ſeen in the preceding figure, on the verge D, where the pallet *g h* is repreſented by the dotted line 2 *i′*, as ſituated behind the pallet *c d*. The remote pallet 2 *i* is ſo placed, that when the point *d* of the near pallet is quitted by a pin 1 on the upper ſide of the wheel, the angle formed by the face and the arch of reſt of the other pallet is juſt ready to receive the next pin 2, which lies on the lower ſide of the rim. It is plain that the action here will be the ſame as if the pallets were on ſeparate axes. The pin 1 eſcapes from *d*, and the pin 2 is received on the arch of reſt, and locks the wheel, while the balance continues in motion. When the balance returns, 2 gets off the arch of reſt, puſhes aſide the pallet 2 *i*, eſcapes from it when *i* gets to 1, and then the point *c* is ready to receive the pin 3, &c. The vibrations may be increaſed by giving a ſufficient impulſe through the angle of ſcapement, but they cannot exceed a certain quantity, otherwiſe N, the top of the crank, would ſtrike the rim of the wheel. The vibrations may be eaſily increaſed to 180°, by placing the pins at the very edge of the wheel; and by placing them at the points of long teeth, ſo that the crank may get in between them, the vibrations may be carried to a much greater extent.

The conſtruction juſt deſcribed is exceedingly ingenious; and if the machinery be well executed, this ſcapement will excel the horizontal ſcapement of Graham, both as it has but two acting faces to form, and as it admits of making the circle of reſt extremely ſmall, without leſſening the acting face of the pallet. The conſtruction is, however, very delicate and difficult, and muſt require a very nice workman.

WATCH Work. Plate DLXXI.

Fig. 1.

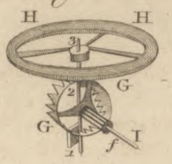


Fig. 2.

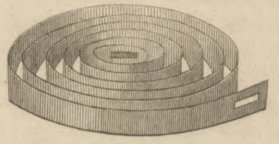


Fig. 3.

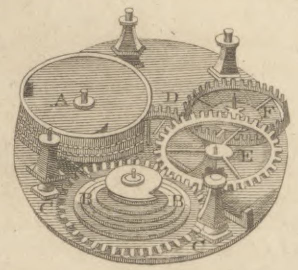


Fig. 4.

Fig. 5.

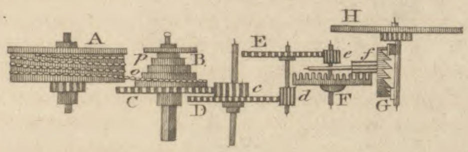


Fig. 6.

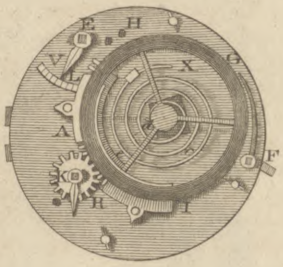


Fig. 7.

Fig. 8.

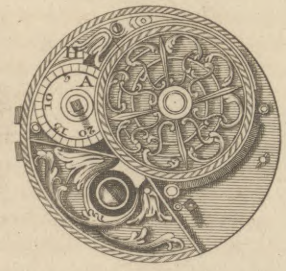


Fig. 9.

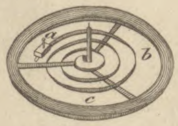


Fig. 10.

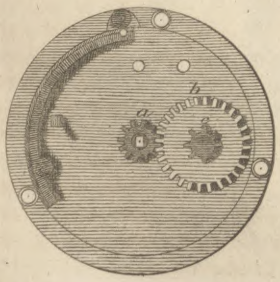
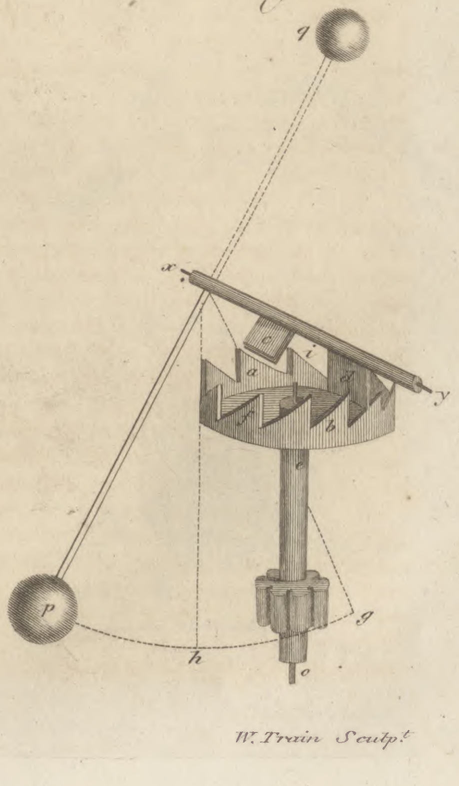


Fig. 11.

Fig. 12.



W. Train Sculpt.

Fig. 13.

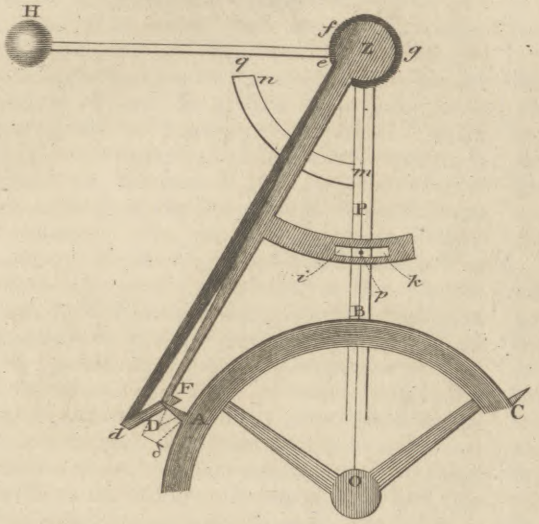


Fig. 14.

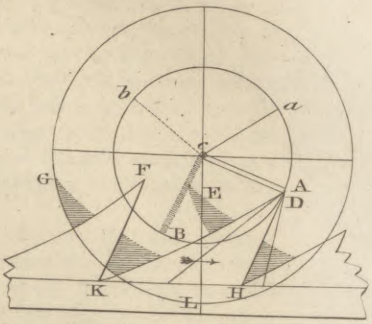


Fig. 15.

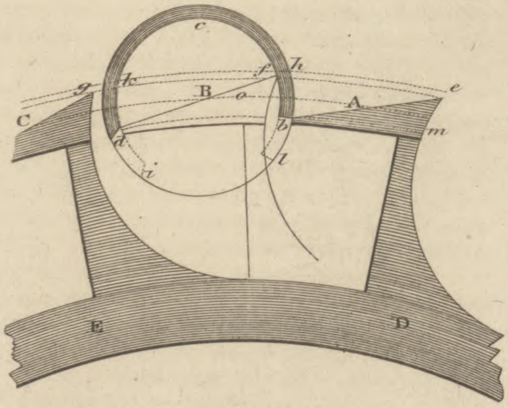


Fig. 16.

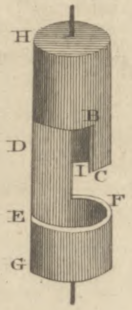


Fig. 17.

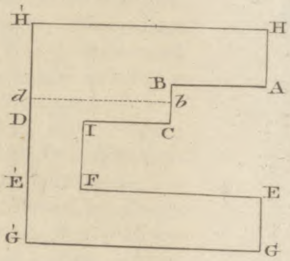


Fig. 18.

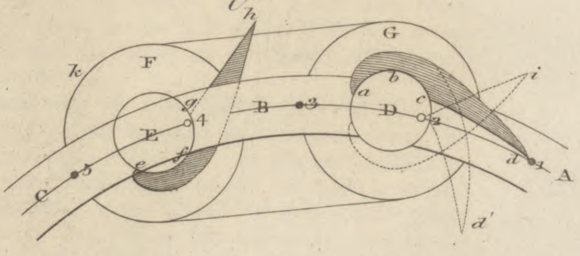


Fig. 19.

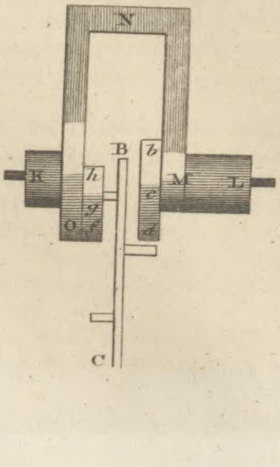
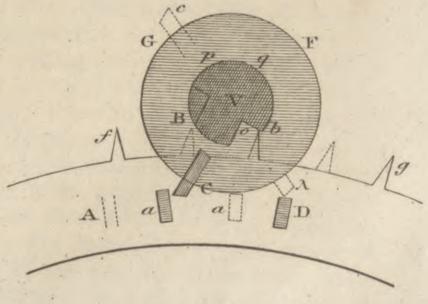


Fig. 20.



W. Train Sculpt.

9 Duplaie's ſcapement. Fig. 20.

An excellent ſcapement of much more eaſy conſtruction, is that commonly called *Duplaie's ſcapement*, and with this we ſhall conclude our account of watch-work. Fig, 20. repreſents the eſſential parts ſomewhat magnified. AD a portion of the balance-wheel, having teeth *f*, *h*, *g*, at the circumference. Theſe teeth are for producing the *reſt* of the wheel, while the balance is making excurſions beyond the ſcapement. This is effected by an agate cylinder *s p g*, on the verge. This cylinder has a notch *o*. When the cylinder turns round in the direction *o p g*, the notch eaſily paſſes the tooth B which is reſting on the cylinder ſurface ; but when it returns in the direction *q p o*, the tooth B gets into the notch, and follows it, preſſing on one ſide of it till the notch comes into the poſition *o*. The tooth being then in the poſition *h*, eſcapes from the notch, and another tooth drops on the convex ſurface of the cylinder at B. The balance-wheel is alſo furniſhed with a ſet of flat-ſided pins, ſtanding upright on its rim repreſented by *a* D. There is likewiſe fixed on the verge a larger cylinder GFC above the ſmaller one *o p q*, with its lower ſurface clear of the wheel, and having a pallet C, of ſapphire, firmly indented into it, and projecting ſo far as to keep clear of the pins on the wheel. The poſition of this cylinder, with reſpect to the ſmaller one below it, is ſuch that the tooth *b* being eſcaped from the notch, the pallet C has juſt paſt the pin *a*, which was at A while B reſted on the ſmall cylinder ; but it moved from A to *a*, while B moved to *b*. The wheel being now at liberty, the pin *a* exerts its preſſure on the pallet C in the moſt direct manner, and gives it a ſtrong impulſion, following and accelerating it till another tooth ſtops on the little cylinder. The angle of ſcapement depends partly on the projection of the pallet, and partly on the diameter of the ſmall cylinder, and the advance of the tooth B into the notch. Independent of the action on the ſmall cylinder, the angle of ſcapement would be the whole arch of the larger cylinder between C and *κ*. But *a* ſtops before it be clear of the pallet, and the arch of impulſion is ſhortened by all the ſpace deſcribed by the pin while a tooth moves from B to *b*. It ſtops at *d*.

For an account of other ſcapements we muſt refer our readers to the *Memoirs of the Academy of Sciences at Paris* for 1748, Cumming's *Elements of Clock and Watch-work*, a French work entitled *Machines approuvées par l'Academie des Sciences*, and Young's *Lectures on Natural Philoſophy*, vol. i. p. 193, and Plate 16, vol. ii. p. 193.

WATCHING, in *Medicine*, is when the patient cannot ſleep. In fevers it is a dangerous ſymptom, and if long continued ends in a delirium.

WATER, a well known fluid, diffuſed through the atmoſphere, and over the ſurface of the globe, and abounding in a certain proportion in animals, vegetables, and minerals.

The uſes of water are ſo univerſally known, that it would be ſuperfluous to enumerate them in this article. It is eſſential to animal and vegetable life ; it makes eaſy the intercourſe between the moſt diſtant regions of the world ; and it is one of the moſt uſeful powers in the mechanic arts. It is often found combined with various ſubſtances, and is then frequently beneficial in curing or alleviating diſeaſes.

Thoſe properties of water which fit it for anſwering mechanical purpoſes are explained in other articles of this Work (ſee HYDRODYNAMICS, PNEUMATICS, N° 3. RESISTANCE, and RIVERS) ; and for the diſcovery of the compoſition of water, ſee CHEMISTRY *Index*.

Mineral WATERS. For the method of analyſing them, ſee alſo CHEMISTRY *Index*.

Under the title of *MINERAL Waters*, we have given an analyſis of the moſt remarkable waters in Europe.

Holy WATER, which is made uſe of in the church of Rome, as alſo by the Greeks, and by the other Chriſtians of the Eaſt of all denominations, is water with a mixture of ſalt, bleſſed by a prieſt according to a ſet form of benediction. It is uſed in the bleſſing of perſons, things, and places ; and is likewiſe conſidered as a ceremony to excite pious thoughts in the minds of the faithful.

The prieſts, in bleſſing it, firſt, in the name of God, commands the devils not to hurt the perſons who ſhall be ſprinkled with it, nor to abuſe the things, nor diſquiet the places, which ſhall likewiſe be ſo ſprinkled. He then prays that health, ſafety, and the favour of heaven, may be enjoyed by ſuch perſons, and by thoſe who ſhall uſe ſuch things, or dwell in ſuch places. Veſtments, veſſels, and other ſuch things that are ſet apart for divine ſervice, are ſprinkled with it. It is ſometimes ſprinkled on cattle, with an intention to free or preſerve them from diabolical enchantments ; and in ſome ritual books there are prayers to be ſaid on ſuch occaſions, by which the ſafety of ſuch animals, as being a temporal bleſſing to the poſſeſſors, is begged of God, whoſe providential care is extended to all his creatures. The hope which Catholics entertain of obtaining ſuch good effects from the devout uſe of holy water, is grounded on the promiſe made to believers by Chriſt (St Mark xvi. 17.), and on the general efficacy of the prayers of the church ; the petition of which prayers God is often pleaſed to grant ; though ſometimes, in his Providence, he ſees it not expedient to do ſo. That ſuch effects have been produced by holy water in a remarkable manner, has been aſſerted by many authors of no ſmall weight ; as, namely, by St Epiphanius, Haer. 30th ; St Hierom, in the Life of St Hilarion ; Theodoret *Hiſt. Eccl.* lib. v. cap. 21. ; Palladius, *Hiſt. Lauſ.* ; Bede, lib. v. cap. 4.

As a ceremony (ſays the Catholic), water brings to our remembrance our baptiſm ; in which, by water, we were cleanſed from original ſin. It alſo puts us in mind of that purity of conſcience which we ought to endeavour always to have, but eſpecially when we are going to worſhip our God. The ſalt, which is put into the water to preſerve it from corrupting, is alſo a figure of divine grace, which preſerves our ſouls from the corruption of ſin ; and is likewiſe an emblem of that wiſdom and diſcretion which ought to ſeaſon every action that a Chriſtian does, and every word that he ſays. It is wont to be bleſſed and ſprinkled in churches on Sundays, in the beginning of the ſolemn office. It is kept in veſſels at the doors of the ſame churches, that it may be taken by the faithful as they enter in. It is alſo often kept in private houſes and chambers.

Putrid WATER, is that which has acquired an offenſive ſmell and taſte by the putreſcence of animal or vegetable ſubſtances contained in it. It is in the higheſt degree pernicious to the human frame, and capable of bringing on mortal diſeaſes even by its ſmell. It is not always from the apparent muddineſs of waters than we can

can judge of their diſpoſition to putrefy; ſome which are ſeemingly very pure being more apt to become putrid than others which appear much more mixed with heterogeneous matters. Under the article ANIMALCULE, N° 33, is mentioned a ſpecies of inſects which have the property of making water ſtink to an incredible degree, though their bulk in proportion to the fluid which ſurrounds them is leſs than that of one to a million. Other ſubſtances no doubt there are which have the ſame property; and hence almoſt all water which is confined from the air is apt to become offenſive, even though kept in glaſs or ſtoneware veſſels. Indeed it a common obſervation, that water keeps much longer ſweet in glaſs veſſels, or in thoſe of earthen or ſtoneware, than in thoſe of wood, where it is exceedingly apt to putrefy. Hence, as ſhips can only be ſupplied with water kept in wooden caſks, ſailors are extremely liable to thoſe diſeaſes which ariſe from putrid water; and the diſcovery of a method by which water could eaſily be prevented from becoming putrid at ſea would be exceedingly valuable. This may indeed be done by quicklime; for when water is impregnated with it, all putreſcent matters are either totally deſtroyed, or altered in ſuch a manner as never to be capable of undergoing the putrefactive fermentation again. But a continued uſe of lime-water could not fail of being pernicious, and it is therefore neceſſary to throw down the lime; after which the water will have all the purity neceſſary for preſerving it free from putrefaction. This can only be done by means of fixed air; and mere expoſure in broad ſhallow veſſels to the atmoſphere would do it without any thing elſe, only taking care to break the cruſt which formed upon it. Two methods, however, have been thought of for doing this with more expedition. The one, invented by Dr Alſton, is, by throwing into the water impregnated with lime a quantity of magneſia. The lime attracts fixed air more powerfully than magneſia; in conſequence of which the latter parts with it to the lime: and thus becoming inſoluble, falls along with the cauſtic magneſia to the bottom, and thus leaves the water perfectly pure. Another method is that of Mr Henry, who propoſes to throw down the lime by means of an effervеſcing mixture of oil of vitriol and chalk put down to the bottom of the water caſk. His apparatus for this purpoſe is as ſimple as it can well be made, though it is hardly probable that ſailors will give themſelves the trouble of uſing it; and Dr Alſton's ſcheme would ſeem better calculated for them, were it not for the expence of the magneſia; which indeed is the only objection made to it by Mr Henry. Putrid water may be reſtored and made potable by a proceſs of the ſame kind.

Of late it has been diſcovered that charcoal poſſeſſes many unexpected properties, and, among others, that of preſerving water from corruption, and of purifying it after it has been corrupted. Mr Lowitz, whoſe experiments on charcoal have been publiſhed in Crell's Chemical Journal, has turned his attention to this ſubject in a memoir read to the Economical Society at Peterſburgh. He found that the effect of charcoal was rendered much more ſpeedy by uſing along with it ſome ſulphuric acid. One ounce and a half of charcoal in powder, and 24 drops of concentrated ſulphuric acid (oil of vitriol), are ſufficient to purify three pints and a half of corrupted water, and do not communicate to it any ſenſible acidity. This ſmall quantity of acid renders it unneceſſary to uſe more than a third part of the charcoal powder which would otherwiſe be wanted; and the leſs of that powder is employed, the leſs is the quantity of water loſt by the operation, which, in ſea-voyages, is an object worthy of conſideration. In proportion to the quantity of acid made uſe of, the quantity of charcoal may be diminiſhed or augmented. All acids produce nearly the ſame effects: neutral ſalts alſo, particularly nitre and ſea-ſalt, may be uſed, but ſulphuric acid is preferable to any of theſe; water which is purified by means of this acid and charcoal will keep a longer time than that which is purified by charcoal alone. When we mean to purify any given quantity of corrupted water, we ſhould begin by adding to it as much powder of charcoal as is neceſſary to deprive it entirely of its bad ſmell. To aſcertain whether that quantity of powdered charcoal was ſufficient to effect the clarification of the ſaid water, a ſmall quantity of it may be paſſed through a linen bag, two or three inches long; if the water, thus filtrated, ſtill has a turbid appearance, a freſh quantity of powdered charcoal muſt be added, till it is become perfectly clear: the whole of the water may then be paſſed through a filtering bag, the ſize of which ſhould be proportioned to the quantity of water. If ſulphuric acid, or any other, can be procured, a ſmall quantity of it ſhould be added to the water, before the charcoal powder.

The cleaning of the caſks in which water is to be kept in ſea-voyages ſhould never be neglected: they ſhould be well waſhed with hot water and ſand, or with any other ſubſtance capable of removing the mucilaginous particles, and afterwards a quantity of charcoal duſt ſhould be employed, which will entirely deprive them of the muſty or putrid ſmell they may have contracted.—The charcoal uſed for purifying water ſhould be well burnt, and afterwards beat into a fine powder.

Sea-WATER. See *SEA-Water.*

WATER-Carts, carriages conſtructed for the purpoſe of watering the roads for ſeveral miles round London; a precaution abſolutely neceſſary near the metropolis, where, from ſuch a vaſt daily influx of carriages and horſes, the duſt would otherwiſe become quite inſufferable in hot dry weather. Pumps are placed at proper diſtances to ſupply theſe carts.

WATER-Ordeal. See ORDEAL.

WATER, among jewellers, is properly the colour or luſtre of diamonds and pearls. The term, though leſs properly, is ſometimes uſed for the hue or colour of other ſtones.

WATER-Bellows. See *Machines for blowing Air into FURNACES.*

WATER-Colours, in *Painting*, are ſuch colours as are only diluted and mixed up with gum-water, in contradiſtinction to oil-colours. See *COLOUR-Making.*

WATER-Gang, a channel cut to drain a place by carrying off a ſtream of water.

WATER-Hen. See PARRA, ORNITHOLOGY *Index.*

WATER-Lines of a Ship, certain horizontal lines ſuppoſed to be drawn about the outſide of a ſhip's bottom, cloſe to the ſurface of the water in which ſhe floats. They are accordingly higher or lower upon the bottom, in proportion to the depth of the column of water required to float her.

WATER-Logged, the ſtate of a ſhip when, by receiving a great quantity of water into the hold, by leaking, &c.

Water-logged
‖
Water-ſpout.

ſhe has become heavy and inactive upon the ſea, ſo as to yield without reſiſtance to the efforts of every wave ruſhing over her decks. As, in this dangerous ſituation, the centre of gravity is no longer fixed, but fluctuating from place to place, the ſtability of the ſhip is utterly loſt: ſhe is therefore almoſt totally deprived of the uſe of her ſails, which would operate to overſet her, or preſs the head under water. Hence there is no reſource for the crew, except to free her by the pumps, or to abandon her by the boats as ſoon as poſſible.

WATER-Sail, a ſmall ſail ſpread occaſionally under the lower ſtudding-ſail, or driver-boom, in a fair wind and ſmooth ſea.

WATER-Ouzel. See TURDUS, ORNITHOLOGY *Index*.

WATER-Spout, an extraordinary meteor, conſiſting of a large maſs of water collected into a ſort of column, and moved with rapidity along the ſurface of the ſea.

The beſt account of the water-ſpout which we have met with is in the Phil. Tranſ. Abridged, vol. viii. as obſerved by Mr Joſeph Harris, May 21. 1732, about ſunſet, lat. 32° 30′ N.; long. 9° E. from Cape Florida.

“ When firſt we ſaw the ſpout (ſays he), it was whole and entire, and much of the ſhape and proportion of a ſpeaking trumpet; the ſmall end being downwards, and reaching to the ſea, and the big end terminated in a black thick cloud. The ſpout itſelf was very black, and the more ſo the higher up. It ſeemed to be exactly perpendicular to the horizon, and its ſides perfectly ſmooth, without the leaſt ruggedneſs. Where it fell the ſpray of the ſea roſe to a conſiderable height, which made ſomewhat the appearance of a great ſmoke. From the firſt time we ſaw it, it continued whole about a minute, and till it was quite diſſipated about three minutes. It began to waſte from below, and ſo gradually up, while the upper part remained entire, without any viſible alteration, till at laſt it ended in the black cloud above; upon which there ſeemed to fall a very heavy rain in that neighbourhood.—There was but little wind, and the ſky elſewhere was pretty ſerene.”

Water-ſpouts have by ſome been ſuppoſed to be merely electrical in their origin; particularly by Signior Beccaria, who ſupported his opinion by ſome experiments. But if we attend to the ſucceſſive phenomena neceſſary to conſtitute a complete water-ſpout through their various ſtages, we ſhall be convinced, that recourſe muſt be had to ſome other principle in order to obtain a complete ſolution.

Dr Franklin, in his Phyſical and Meteorological Obſervations, ſuppoſes a water-ſpout and a whirlwind to proceed from the ſame cauſe; their only difference being, that the latter paſſes over the land, and the former over the water. This opinion is corroborated by M. de la Pryme, in the Philoſophical Tranſactions, where he deſcribes two ſpouts obſerved at different times in Yorkſhire, whoſe appearances in the air were exactly like thoſe of the ſpouts at ſea, and their effects the ſame as thoſe of real whirlwinds.

A fluid moving from all points horizontally towards a centre, muſt at that centre either mount or deſcend. If a hole be opened in the middle of the bottom of a tub filled with water, the water will flow from all ſides to the centre, and there deſcend in a whirl: but air flowing on or near the ſurface of land or water, from all ſides towards a centre, muſt at that centre aſcend; becauſe the land or water will hinder its deſcent.

Water-ſpout.

The doctor, in proceeding to explain his conceptions, begs to be allowed two or three poſitions, as a foundation for his hypotheſis. 1. That the lower region of air is often more heated, and ſo more rarefied, than the upper, and by conſequence ſpecifically lighter. The coldneſs of the upper region is manifeſted by the hail, which falls from it in warm weather. 2. That heated air may be very moiſt, and yet the moiſture ſo equally diffuſed and rarefied as not to be viſible till colder air mixes with it; at which time it condenſes and becomes viſible. Thus our breath, although inviſible in ſummer, becomes viſible in winter.

Theſe circumſtances being granted, he preſuppoſes a tract of land or ſea, of about 60 miles in extent, unſheltered by clouds and unrefreſhed by the wind, during a ſummer's day, or perhaps for ſeveral days without intermiſſion, till it becomes violently heated, together with the lower region of the air in contact with it; ſo that the latter becomes ſpecifically lighter than the ſuperincumbent higher region of the atmoſphere, wherein the clouds are uſually floated: he ſuppoſes alſo that the air ſurrounding this tract has not been ſo much heated during thoſe days, and therefore remains heavier. The conſequence of this, he conceives, ſhould be, that the heated lighter air ſhould aſcend, and the heavier deſcend; and as this riſing cannot operate throughout the whole tract at once, becauſe that would leave too extenſive a vacuum, the riſing will begin preciſely in that column which happens to be lighteſt or moſt rarefied; and the warm air will flow horizontally from all parts of this column, where the ſeveral currents meeting, and joining to riſe, a whirl is naturally formed, in the ſame manner as a whirl is formed in a tub of water, by the deſcending fluid receding from all ſides of the tub towards the hole in the centre.

And as the ſeveral currents arrive at this central riſing column with a conſiderable degree of horizontal motion, they cannot ſuddenly change it to a vertical motion: therefore as they gradually, in approaching the whirl, decline from right to curve or circular lines, ſo, having joined the whirl, they aſcend by a ſpiral motion; in the ſame manner as the water deſcends ſpirally through the hole in the tub before mentioned.

Laſtly, as the lower air neareſt the ſurface is more rarefied by the heat of the ſun, it is more impreſſed by the current of the ſurrounding cold and heavy air which is to aſſume its place, and conſequently its motion towards the whirl is ſwifteſt, and ſo the force of the lower part of the whirl ſtrongeſt, and the centrifugal force of its particles greateſt. Hence the vacuum which incloſes the axis of the whirl ſhould be greateſt near the earth or ſea, and diminiſh gradually as it approaches the region of the clouds, till it ends in a point.

This circle is of various diameters, ſometimes very large.

If the vacuum paſſes over water, the water may riſe in a body or column therein to the height of about 32 feet. This whirl of air may be as inviſible as the air itſelf, though reaching in reality from the water to the region of cool air, in which our low ſummer thunder-clouds commonly float; but it will ſoon become viſible at its extremities. The agitation of the water under the whirling of the circle, and the ſwelling and riſing of the water in the commencement of the vacuum, renders it viſible below. It is perceived above by the warm air being brought up to the cooler region, where its moiſture begins to be condenſed by the cold into thick vapour, and is then firſt diſcovered at the higheſt part, which being now cooled condenſes what riſes behind it, and this latter acts in the ſame manner on the ſucceeding body; where, by the contact of the vapours, the cold operates faſter in a right line downwards, than the vapours themſelves can climb in a ſpiral line upwards: they climb however; and as by continual addition they grow denſer, and by conſequence increaſe their centrifugal force, and being riſen above the concentrating currents that compoſe the whirl, they fly off, and form a cloud.

It ſeems eaſy to conceive, how, by this ſucceſſive condenſation from above, the ſpout appears to drop or deſcend from the cloud, although the materials of which it is compoſed are all the while aſcending. The condenſation of the moiſture contained in ſo great a quantity of warm air as may be ſuppoſed to riſe in a ſhort time in this prodigiouſly rapid whirl, is perhaps ſufficient to form a great extent of cloud; and the friction of the whirling air on the ſides of the column may detach great quantities of its water, diſperſe them into drops, and carry them up in the ſpiral whirl mixed with the air. The heavier drops may indeed fly off, and fall into a ſhower about the ſpout; but much of it will be broken into vapour, and yet remain viſible.

As the whirl weakens, the tube may apparently ſeparate in the middle; the column of water ſubſiding, the ſuperior condenſed part drawing up to the cloud. The tube or whirl of air may neverthelefs remain entire, the middle only becoming inviſible, as not containing any viſible matter.

Dr Lindſay, however, in ſeveral letters publiſhed in the Gentleman's Magazine, has controverted this theory of Dr Franklin, and endeavoured to prove, that water-ſpouts and whirlwinds are diſtinct phenomena; and that the water which forms the water-ſpout, does not aſcend from the ſea, as Dr Franklin ſuppoſes, but deſcends from the atmoſphere. Our limits do not permit us to inſert his arguments here, but they may be ſeen in the Gentleman's Magazine, volume li. p. 559, 615; vol. liii. p. 1025; and vol. lv. p. 594. We cannot avoid obſerving, however, that he treats Dr Franklin with a degree of aſperity to which he is by no means entitled, and that his arguments, even if concluſive, prove nothing more than that ſome water-ſpouts certainly deſcend; which Dr Franklin hardly ever ventured to deny. There are ſome very valuable diſſertations on this ſubject by Profeſſor Wilcke of Upſal.

WATER-Works. Under this name may be comprehended almoſt every hydraulic ſtructure or contrivance; ſuch as, canals, conduits, locks, mills, water engines, &c. But they may be conveniently arranged under two general heads, 1ſt, Works which have for their object the conducting, raiſing, or otherwiſe managing, of water; and, 2dly, Works which derive their efficacy from the impulſe or other action of water. The *firſt* claſs comprehends the methods of ſimply conducting water in aqueducts or in pipes for the ſupply of domeſtic conſumption or the working of machinery: It comprehends alſo the methods of procuring the ſupplies neceſſary for theſe purpoſes, by means of pumps, water, or fire engines. It alſo comprehends the ſubſequent management of the water thus conducted, whether in order to make the proper diſtribution of it according to the demand, or to employ it for the purpoſe of navigation, by lockage, or other contrivances. —And in the proſecution of theſe things many ſubordinate problems will occur, in which practice will derive great advantages from a ſcientific acquaintance with the ſubject. The *ſecond* claſs of water-works is of much greater variety, comprehending almoſt every kind of hydraulic machine; and would of itſelf fill volumes. Many of theſe have already occurred in various articles of this Dictionary. In deſcribing or treating them, we have tacitly referred the diſcuſſion of their general principles, in which they all reſemble each other, to ſome article where they could be taken in a connected body, ſuſceptible of general ſcientific diſcuſſion, independent of the circumſtances which of neceſſity introduced the particular modifications required by the uſes to which the ſtructures were to be applied. That part of the preſent article, therefore, which embraces theſe common principles, will chiefly relate to the theory of water mills, or rather of water wheels; becauſe, when the neceſſary motion is given to the axis of the water wheel, this may be ſet to the performance of any taſk whatever.

CLASS I.

1. *Of the conducting of Water.*

THIS is undoubtedly a buſineſs of great importance, and makes a principal part of the practice of the civil engineer: It is alſo a buſineſs ſo imperfectly underſtood, that we believe that very few engineers can venture to ſay, with tolerable preciſion, what will be the quantity of water which his work will convey, or what plan and dimenſions of conduit will convey the quantity which may be propoſed. For proof of this we ſhall only refer our readers to the facts mentioned in the article RIVERS, N° 27, &c.

In that article we have given a ſort of hiſtory of the progreſs of our knowledge in hydraulics, a branch of mechanical philoſophy which ſeems to have been entirely unknown to the ancients. Even Archimedes, the author of almoſt all that we know in hydroſtatics, ſeems to have been entirely ignorant of any principles by which he could determine the motion of water. The mechanical ſcience of the ancients ſeems to have reachno farther than the doctrine of equilibrium among bodies at reſt. Guglielmini firſt ventured to conſider the motion of water in open canals and in rivers. Its motion in pipes had been partially conſidered in detached ſcraps by others, but not ſo as to make a body of doctrine. Sir Iſaac Newton firſt endeavoured to render hydraulics ſuſceptible of mathematical demonſtration: But his fundamental propoſition has not yet been freed from very ſerious objections; nor have the attempts of his ſucceſſors, ſuch as the Bernoullis, Euler, D'Alembert, and others, been much more ſucceſsful: ſo that hydraulics may ſtill be conſidered as very imperfect, and the general concluſions which we are accuſtomed to receive as fundamental propoſitions are not much better than matters of obſervation, little ſupported by principle, and therefore requiring the moſt ſcrupulous

lous caution in the application of them to any hitherto untried caſe. When experiments are multiplied ſo as to include as great a variety of caſes as poſſible; and when theſe are cleared of extraneous circumſtances, and properly arranged, we muſt receive the concluſions drawn from them as the general laws of hydraulics. The experiments of the abbé Boſſut, narrated in his *Hydrodynamique*, are of the greateſt value, having been made in the caſes of moſt general frequency, and being made with great care. The greateſt ſervice, however, has been done by the chevalier Buat, who ſaw the folly of attempting to deduce an accurate theory from any principles that we have as yet learned, and the neceſſity of adhering to ſuch a theory as could be deduced from experiment alone, independent of any more general principles. Such a theory muſt be a juſt one, if the experiments are really general, unaffected by the particular circumſtances of the caſe, and if the claſſes of experiment are ſufficiently comprehenſive to include all the caſes which occur in the moſt important practical queſtions. Some principle was neceſſary, however, for connecting theſe experiments. The ſufficiency of this principle was not eaſily aſcertained. M. Buat's way of eſtabliſhing this was judicious. If the principle is ill-founded, the reſults of its combination in caſes of actual experiments muſt be irregular; but if experiments, ſeemingly very unlike, and in a vaſt variety of diſſimilar caſes, give a train of reſults which is extremely regular and conſiſtent, we may preſume that the principle, which in this manner harmonizes and reconciles things ſo unlike, is founded in the nature of things; and if this principle be ſuch as is agreeable to our cleareſt notions of the internal mechaniſm of the motions of fluids, our preſumption approaches to conviction.

Proceeding in this way, the chevalier Buat has collected a prodigious number of facts, comprehending almoſt every caſe of the motion of fluids. He firſt claſſed them according to their reſemblance in ſome one particular, and obſerved the differences which accompanied their differences in other circumſtances; and by conſidering what could produce theſe differences, he obtained general rules, deduced from fact, by which theſe differences could be made to fall into a regular ſeries. He then arranged all the experiments under ſome other circumſtances of reſemblance, and purſued the ſame method; and by following this out, he has produced a general propoſition, which applies to the whole of this numerous liſt of experiments with a preciſion far exceeding our utmoſt hopes. This propoſition is contained in N° 59. of the article Rivers, and is there offered as one of the moſt valuable reſults of modern ſcience.

We muſt, however, obſerve, that of this liſt of experiments there is a very large claſs, which is not direct, but requires a good deal of reflection to enable us to draw a confident concluſion; and this is in caſes which are very frequent and important, viz. where the declivity is exceedingly ſmall, as in open canals and rivers. The experiments were of the following forms: Two large ciſterns were made to communicate with each other by means of a pipe. The ſurfaces of the water in theſe ciſterns were made to differ only by a ſmall fraction of an inch: and it is ſuppoſed that the motion in the communicating pipe will be the ſame as in a very long pipe, or an open canal, having this very minute declivity. We have no difficulty in admitting the concluſion; but we have ſeen it conteſted, and it is by no means intuitive. We had entertained hopes that this important caſe would have been determined by direct experiments, which the writer of this article was commiſſioned to make by the Board for Encouraging Improvements and Manufactures in Scotland: But the infirm ſtate of his health was always an effectual bar to the accompliſhment of this deſirable object. This, however, need not occaſion any heſitation in the adoption of M. Buat's general propoſition, becauſe the experiments which we are now criticiſing fall in preciſely with the general train of the reſt, and ſhow no *general* deviation which would indicate a fallacy in principle.

We apprehend it to be quite unneceſſary to add much to what has been already delivered on the motion of waters in an open canal. Their *general progreſſive* motion, and conſequently the quantity delivered by an aqueduct of any ſlope and dimenſion, are ſufficiently determined; and all that is wanted is the tables which we promiſed in N° 65. of the article Rivers, by which any perſon who underſtands common arithmetic may, in five minutes time or leſs, compute the quantity of water which will be delivered by the aqueduct, canal, conduit, or pipe; for the theorem in N° 59. of this article applies to them all without diſtinction. We therefore take this opportunity of inſerting theſe tables, which have been computed on purpoſe for this work with great labour.

TABLE I. *Logarithms of the Values of the Numerator of the Fraction* $\frac{307\,(\sqrt{d}-0{,}1)}{\sqrt{s}-\mathrm{L}\sqrt{s+1{,}6}}$ *for every Value of the Hydraulic mean Depth* d: *Also the Value of* 0,3 ($\sqrt{d}$—0,1).

d.	Log. of 307 ($\sqrt{d}$—0,1)	0,3 × ($\sqrt{d}$—0,1)	*d.*	Log. of 307 ($\sqrt{d}$—0,1)	0,3 × ($\sqrt{d}$—0,1)	*d.*	Log. of 307 ($\sqrt{d}$—0,1)	0,3 × ($\sqrt{d}$—0,1)	*d.*	Log. of 307 ($\sqrt{d}$—0,1)	0,3 × ($\sqrt{d}$—0,1)
0,1	1.82208	0,06	4,9	2.81216	0,63	9,7	2.96634	0,9	54	3.34738	2,17
0,2	2.02786	0,1	5,0	2.81674	0,63	9,8	2.96865	0,91	55	3.35143	2,19
0,3	2.13753	0,13	5,1	2.82125	0,65	9,9	2.97093	0,91	56	3.35539	2,21
0,4	2.21343	0,16	5,2	2.82567	0,65	10	2.97319	0,92	57	3.35928	2,23
0,5	2.27040	0,18	5,3	2.83000	0,66	11	2.99454	0,97	58	3.36312	2,25
0,6	2.31618	0,2	5,4	2.83222	0,67	12	3.01401	1,01	59	3.36687	2,27
0,7	2.35441	0,22	5,5	2.83840	0,67	13	3.03189	1,05	60	3.37057	2,3
0,8	2.38719	0,24	5,6	2.84248	0,68	14	3.04843	1,09	61	3.37421	2,31
0,9	2.41588	0,25	5,7	2.84648	0,68	15	3.06383	1,13	62	3.37778	2,33
1,0	2.44138	0,27	5,8	2.85043	0,69	16	3.07820	1,17	63	3.38130	2,35
1,1	2.46431	0,28	5,9	2.85431	0,69	17	3.09170	1,21	64	3.38477	2,37
1,2	2.48518	0,3	6,0	2.85812	0,7	18	3.10441	1,24	65	3.38817	2,39
1,3	2.50426	0,31	6,1	2.86185	0,7	19	3.11644	1,28	66	3.39158	2,41
1,4	2.52185	0,32	6,2	2.86554	0,71	20	3.12783	1,31	67	3.39483	2,42
1,5	2.53818	0,34	6,3	2.86916	0,72	21	3.13867	1,34	68	3.39809	2,44
1,6	2.55345	0,35	6,4	2.87271	0,73	22	3.14899	1,38	69	3.40130	2,46
1,7	2.56769	0,36	6,5	2.87622	0,73	23	3.15885	1,41	70	3.40446	2,48
1,8	2.58112	0,37	6,6	2.87966	0,74	24	3.16828	1,44	71	3.40758	2,49
1,9	2.59381	0,38	6,7	2.88306	0,75	25	3.17734	1,47	72	3.41065	2,51
2,0	2.60580	0,39	6,8	2.88641	0,75	26	3.18601	1,5	73	3.41369	2,53
2,1	2.61713	0,4	6,9	2.88971	0,76	27	3.19438	1,53	74	3.41667	2,55
2,2	2.62803	0,41	7,0	2.89296	0,76	28	3.20243	1,56	75	3.41962	2,57
2,3	2.63839	0,42	7,1	2.89614	0,77	29	3.21020	1,58	76	3.42253	2,58
2,4	2.64827	0,44	7,2	2.89930	0,77	30	3.21770	1,61	77	3.42540	2,60
2,5	2.65772	0,45	7,3	2.90241	0,78	31	3.22495	1,64	78	3.42823	2,62
2,6	2.66681	0,45	7,4	2.90549	0,78	32	3.23196	1,67	79	3.43103	2,63
2,7	2.67556	0,46	7,5	2.90851	0,79	33	3.23877	1,69	80	3.43380	2,65
2,8	2.68395	0,47	7,6	2.91150	0,79	34	3.24537	1,72	81	3.43653	2,67
2,9	2.69207	0,48	7,7	2.91445	0,8	35	3.25176	1,74	82	3.43923	2,69
3,0	2.69989	0,49	7,8	2.91734	0,8	36	3.25799	1,77	83	3.44189	2,7
3,1	2.70743	0,5	7,9	2.92022	0,81	37	3.26404	1,79	84	3.44452	2,72
3,2	2.71472	0,51	8,0	2.92305	0,82	38	3.26993	1,82	85	3.44712	2,74
3,3	2.72181	0,52	8,1	2.92584	0,82	39	3.27566	1,84	86	3.44968	2,75
3,4	2.72866	0,53	8,2	2.92860	0,83	40	3.28125	1,87	87	3.45222	2,77
3,5	2.73531	0,53	8,3	2.93133	0,83	41	3.28669	1,89	88	3.45473	2,78
3,6	2.74178	0,54	8,4	2.93403	0,84	42	3.29201	1,91	89	3.45721	2,79
3,7	2.74805	0,55	8,5	2.93670	0,84	43	3.29720	1,93	90	3.45965	2,81
3,8	2.75417	0,56	8,6	2.93933	0,85	44	3.30227	1,95	91	3.46208	2,83
3,9	2.76009	0,56	8,7	2.94192	0,85	45	3.30722	1,98	92	4.46448	2,85
4,0	2.76589	0,57	8,8	2.94449	0,86	46	3.31207	2,00	93	3.46685	2,86
4,1	2.77153	0,58	8,9	2.94703	0,86	47	3.31681	2,03	94	3.46920	2,88
4,2	2.77704	0,59	9,0	2.94954	0,87	48	3.32145	2,05	95	3.47152	2,89
4,3	2.78240	0,59	9,1	2.95202	0,87	49	3.32599	2,07	96	3.47381	2,91
4,4	2.78765	0,6	9,2	2.95447	0,88	50	3.33043	2,09	97	3.47608	2,93
4,5	2.79277	0,6	9,3	2.95690	0,88	51	3.33480	2,11	98	3.47833	2,94
4,6	2.79779	0,61	9,4	2.95930	0,89	52	3.33908	2,13	99	3.48056	2,95
4,7	2.80269	0,62	9,5	2.96167	0,89	53	3.34327	2,15	100	3.48277	2,97
4,8	2.80747	0,63	9,6	2.96402	0,9						

TABLE II. *Logarithms of the Values of the Denominator of the Fraction* $\frac{307(\sqrt{d}-0,1)}{\sqrt{s}-\mathrm{L}\sqrt{s+1,6}}$ *for every Value of the Slopes.*

s.	Log. of $\sqrt{s}-\mathrm{L}\sqrt{s+1,6}$	*s.*	Log. of $\sqrt{s}-\mathrm{L}\sqrt{s+1,6}$	*s.*	Log. of $\sqrt{s}-\mathrm{L}\sqrt{s+1,6}$	*s.*	Log. of $\sqrt{s}-\mathrm{L}\sqrt{s+1,6}$	*s.*	Log. of $\sqrt{s}-\mathrm{L}\sqrt{s+1,6}$	*s.*	Log. of $\sqrt{s}-\mathrm{L}\sqrt{s+1,6}$
1,0	9.71784	7,3	0.20651	45	0.67997	170	1.01983	800	1.39690	5200	1.83142
1,1	9.74210	7,4	0.20997	46	0.68574	180	1.03410	810	1.39985	5300	1.83575
1,2	9.76388	7,5	0.21336	47	0.69135	190	1.04751	820	1.40277	5400	1.84002
1,3	9.78376	7,6	0.21674	48	0.69688	200	1.06026	830	1.40564	5500	1.84421
1,4	9.80202	7,7	0.22109	49	0.70226	210	1.07237	840	1.40678	5600	1.84833
1,5	9.81882	7,8	0.22335	50	0.70749	220	1.08390	850	1.41128	5700	1.85237
1,6	9.83461	7,9	0.22663	51	0.71265	230	1.09489	860	1.41408	5800	1.85634
1,7	9.84930	8,0	0.22982	52	0.71767	240	1.10542	870	1.41683	5900	1.86022
1,8	9.86314	8,1	0.23297	53	0.72263	250	1.11553	880	1.41953	6000	1.86404
1,9	9.87622	8,2	0.23611	54	0.72746	260	1.12523	890	1.42220	6100	1.86778
2,0	9.88857	8,3	0.23923	55	0.73223	270	1.13453	900	1.42487	6200	1.87146
2,1	9.90031	8,4	0.24229	56	0.73695	280	1.14345	910	1.42746	6300	1.87507
2,2	9.91153	8,5	0.24532	57	0.74155	290	1.15204	920	1.43005	6400	1.87863
2,3	9.92267	8,6	0.24832	58	0.74601	300	1.16035	930	1.43263	6500	1.88213
2,4	9.93247	8,7	0.25128	59	0.75043	310	1.16838	940	1.43515	6600	1.88558
2,5	9.94231	8,8	0.25422	60	0.75481	320	1.17612	950	1.43464	6700	1.88898
2,6	9.95173	8,9	0.25709	61	0.75906	330	1.18363	960	1.44011	6800	1.89233
2,7	9.96085	9,0	0.25996	62	0.76328	340	1.19092	970	1.44254	6900	1.89564
2,8	9.96942	9,1	0.26281	63	0.76745	350	1.19803	980	1.44498	7000	1.89891
2,9	9.97818	9,2	0.26560	64	0.77151	360	1.20490	990	1.44737	7100	1.90214
3,0	9.98632	9,3	0.26839	65	0.78276	370	1.21158	1000	1.44976	7200	1.90532
3,1	9.99427	9,4	0.27116	66	0.77945	380	1.21806	—		7300	1.90845
3,2	0.00200	9,5	0.27387	67	0.78333	390	1.22435	1100	1.47223	7400	1.91154
3,3	0.00945	9,6	0.27656	68	0.78718	400	1.23048	1200	1.49269	7500	1.91458
3,4	0.01669	9,7	0.27921	69	0.79092	410	1.23647	1300	1.51148	7600	1.91757
3,5	0.02373	9,8	0.28186	70	0.76463	420	1.24232	1400	1.52885	7700	1.92052
3,6	0.03064	9,9	0.28450	71	0.79824	430	1.24805	1500	1.54497	7800	1.92344
3,7	0.03733	10,	0.28709	72	0.80182	440	1.25360	1600	1.56014	7900	1.92632
3,8	0.04383	—		73	0.80536	450	1.25903	1700	1.57416	8000	1.92916
3,9	0.05015	11	0.31170	74	0.80882	460	1.26433	1800	1.58747	8100	1.93197
4,0	0.05638	12	0.33425	75	0.81231	470	1.26951	1900	1.60004	8200	1.93475
4,1	0.06245	13	0.35488	76	0.81571	480	1.27461	2000	1.61195	8300	1.93749
4,2	0.06839	14	0.37420	77	0.81908	490	1.27957	2100	1.62325	8400	1.94020
4,3	0.07412	15	0.39235	78	0.82236	500	1.28445	2200	1.63403	8500	1.94287
4,4	0.07898	16	0.40926	79	0.82562	510	1.28923	2300	1.64432	8600	1.94551
4,5	0.08533	17	0.42521	80	0.82885	520	1.29391	2400	1.65414	8700	1.94811
4,6	0.09081	18	0.44028	81	0.83206	530	1.29851	2500	1.66358	8800	1.95069
4,7	0.09615	19	0.45439	82	0.83525	540	1.30300	2600	1.67261	8900	1.95324
4,8	0.10131	20	0.46776	83	0.83835	550	1.30740	2700	1.68133	9000	1.95576
4,9	0.10644	21	0.48044	84	0.84142	560	1.31172	2800	1.68971	9100	1.95826
5,0	0.11147	22	0.49262	85	0.84442	570	1.31597	2900	1.69780	9200	1.96073
5,1	0.11635	23	0.50433	86	0.84739	580	1.32015	3000	1.70558	9300	1.96317
5,2	0.12108	24	0.51548	87	0.85034	590	1.32426	3100	1.71313	9400	1.96559
5,3	0.12595	25	0.52621	88	0.05327	600	1.32830	3200	1.72042	9500	1.96797
5,4	0.13061	26	0.53656	89	0.85618	610	1.33226	3300	1.72750	9600	1.97033
5,5	0.13519	27	0.54654	90	0.85908	620	1.33614	3400	1.73435	9700	1.97267
5,6	0.13970	28	0.55606	91	0.86189	630	1.33997	3500	1.74099	9800	1.97497
5,7	0.14410	29	0.56526	92	0.86463	640	1.34373	3600	1.74746	9900	1.97726
5,8	0.14844	30	0.57415	93	0.86741	650	1.34743	3700	1.75373	10000	1.97952
5,9	0.15274	31	0.58263	94	0.87017	660	1.35108	3800	1.75984	11000	2.00099
6,0	0.15697	32	0.59095	95	0.87286	670	1.35468	3900	1.76578	12000	2.02056
6,1	0.16113	33	0.59901	96	0.87552	680	1.35823	4000	1.77159	13000	2.03855
6,2	0.16522	34	0.60692	97	0.87818	690	1.36170	4100	1.77725	14000	2.05518
6,3	0.16927	35	0.61448	98	0.88076	700	1.36513	4200	1.78277	15000	2.07065
6,4	0.17322	36	0.62180	99	0.88338	710	1.36851	4300	1.78814	16000	2.08512
6,5	0.17713	37	0.62900	100	0.88593	720	1.37185	4400	1.79339	17000	2.09869
6,6	0.18099	38	0.63599	—		730	1.37513	4500	1.77851	18000	2.11148
6,7	0.18477	39	0.64276	110	0.91014	740	1.37839	4600	1.80352	19000	2.12357
6,8	0.18854	40	0.64933	120	0.93212	750	1.38157	4700	1.80875	20000	2.13503
6,9	0.19229	41	0.65571	130	0.95236	760	1.38471	4800	1.81321	21000	2.14594
7,0	0.19584	42	0.66200	140	0.97109	770	1.38782	4900	1.81790	22000	2.15633
7,1	0.19886	43	0.66811	150	0.98843	780	1.39089	5000	1.82249	23000	2.16624
7,2	0.20298	44	0.67413	160	1.00466	790	1.39391	5100	1.82699	24000	2.17573

TABLE I. conſiſts of three columns.—*Column* 1. entitled *d*, contains the hydraulic mean depths of any conduit in inches. This is ſet down for every 10th of an inch in the firſt 10 inches, that the anſwers may be more accurately obtained for pipes, the mean depth of which ſeldom exceeds three or four inches. The column is continued to 100 inches, which is fully equal to the hydraulic mean depth of any canal.

Column 2. contains the logarithms of the values of $\sqrt{d}-0.1$, multiplied by 307; that is, the logarithm of the numerator of the fraction $\frac{307(\sqrt{d}-0.1)}{\sqrt{s}-L\sqrt{s+1.6}}$ in N° 65. of the article RIVERS.

Column 3. contains the product of the values of $\sqrt{d}-0.1$ multiplied by 0.3

TABLE II. conſiſts of two columns.—*Column* 1. entitled *ſ*, contains the denominator of the fraction expreſsing the ſlope or declivity of any pipe or canal; that is, the quotient of its length divided by the elevation of one extremity above the other. Thus, if a canal of one mile in length be three feet higher at one end than the other, then *ſ* is $\frac{5280}{3}$, $=1760$.

Column 2. contains the logarithms of the denominators of the above mentioned fraction, or of the different values of the quantity $\sqrt{s-L\sqrt{s+1.6}}$.

Theſe quantities were computed true to the third decimal place. Notwithſtanding this, the laſt figure in about a dozen of the firſt logarithms of each table is not abſolutely certain to the neareſt unit. But this cannot produce an error of 1 in 100,000.

Examples of the Uſe of theſe Tables.

Example 1. Water is brought into the city of Edinburgh in ſeveral mains. One of theſe is a pipe of five inches diameter. The length of the pipe is 14.637 feet; and the reſervoir at Comiſton is 44 feet higher than the reſervoir into which it delivers the water on the Caſtle Hill. *Query*, The number of Scotch pints which this pipe ſhould deliver in a minute?

1. We have $d=\frac{5}{4}$, $=1.25$ inches. The logarithm correſponding to this *d*, being nearly the mean between the logarithms correſponding to 1.2 and 1.3 is 2.49472.

2. We have $s=\frac{14637}{44}$, or 332.7. The logarithm correſponding to this in Table II. is had by taking proportional parts for the difference between the logarithms for $s=330$ and $s=340$, and is 1.18533.

3. From 2.49472
Take 1.18533

Remains 1.30939, the logarithm of 20.385 inches.

4. In column 3. of Table I. oppoſite to $d=1.2$ and $d=1.3$ are 0,3 and 0.31, of which the mean is 0.305 inches, the correction for viſcidity.

5. Therefore the velocity in inches per ſecond is 20.385—0.305, or 20.08.

6. To obtain the Scotch pints per minute (each containing 103.4 cubic inches), multiply the velocity by 60, and this product by 5^2, and this by 0.7854 (the area of a circle whoſe diameter is 1), and divide by 103.4. Or, by logarithms,

Add the log. of 20.08 - -	1.30276
log. of 60″ - -	1.77815
log. of 5^2 or 25 - -	1.39794
log. of 0.7854 - -	9.89509
	4.37394
Subtract the log. of 103.4 - -	2.01451
Remains the log. of 228.8 pints -	2.35943

Example 2. The canal mentioned in the article RIVERS, N° 63. was 18 feet broad at the ſurface, and 7 feet at the bottom. It was 4 feet deep, and had a declivity of 4 inches in a mile. *Query*, The mean velocity?

1. The ſlant ſide of the canal, correſponding to 4 feet deep and $5\frac{1}{2}$ projection, is 6.8 feet; therefore the border touched by the water is $6.8+7+6.8$, $=20.6$. The area is $4\times\frac{18+7}{2}$, $=50$ ſquare feet. Therefore $d=\frac{50}{20.6}$, $=2.427$ feet, or 29.124 inches. The logarithm correſponding to this in Table I. is 3.21113, and the correction for viſcidity from the third column of the ſame Table is 1.58.

2. The ſlope is one-third of a foot in a mile, or one foot in three miles. Therefore *ſ* is 15.840. The logarithm correſponding to this is 2.08280.

3. From 3.21113
Subtract 2.08280

Remains 1.12833=log. of 13.438 inches.
Subtract for viſcidity 1.58

Velocity per ſecond - 11.858

This velocity is conſiderably ſmaller than what was obſerved by Mr Watt. And indeed we obſerve, that in the very ſmall declivities of rivers and canals, the formula is a little different. We have made ſeveral compariſons with a formula which is eſſentially the ſame with Buat's, and comes nearer in theſe caſes. Inſtead of taking the hyperbolic logarithm of $\sqrt{s+1.6}$, multiply its common logarithm by $2\frac{1}{4}$, or multiply it by 9, and divide the product by 4; and this proceſs is vaſtly eaſier than taking the hyperbolic logarithm.

We have not, however, preſumed to calculate tables on the authority of our own obſervations, thinking too reſpectfully of this gentleman's labours and obſervations. But this ſubject will, ere long, be fully eſtabliſhed on a ſeries of obſervations on canals of various dimenſions and declivities, made by ſeveral eminent engineers during the execution of them. Fortunately Mr Buat's formula is chiefly founded on obſervations on ſmall canals; and is therefore moſt accurate in ſuch works where it is moſt neceſſary, viz. in mill courſes, and other derivations for working machinery.

We now proceed to take notice of a few circumſtances which deſerve attention, in the conſtruction of canals, in addition to thoſe delivered in the article RIVERS.

When a canal or aqueduct is brought off from a baſon or larger ſtream, it ought always to be widened at the entry, if it is intended for drawing off a continued ſtream of water: For ſuch a canal has a ſlope, without which it can have no current. Suppoſe it filled to a dead level to the farther end: Take away the bar, and the water immediately begins to flow off at that end. But it is ſome time before any motion is perceived at the head of the canal, during all which time the motion of the water is augmenting in every part of the canal; conſequently the ſlope is increaſing in every part, this being the ſole cauſe of its ſtream. When the water at the entry *begins* to move, the ſlope is ſcarcely ſenſible there; but it ſenſibly ſteepens every moment with the increaſe of velocity, which at laſt attains its maximum relative to the ſlope and dimenſions of the whole canal; and this regulates the depth of water in every point down the ſtream. When all has attained a ſtate of permanency, the ſlope at the entry *remains* much greater than in any other part of the canal; for this ſlope muſt be ſuch as will produce a velocity ſufficient for ſupplying its TRAIN.

And it muſt be remembered, that the velocity which muſt be produced greatly exceeds the mean velocity correſponding to the train of the canal. Suppoſe that this is 25 inches. There muſt be a velocity of 30 inches at the ſurface, as appears by the Table in the article RIVERS, N° 80. This muſt be produced by a real fall at the entry.

In every other part the ſlope is ſufficient, if it merely ſerves to give the water (already in motion) force enough for overcoming the friction and other reſiſtances. But at the entry the water is ſtagnant, if in a baſon, or it is moving paſt laterally, if the aqueduct is derived from a river; and, having no velocity whatever in the direction of the canal, it muſt derive it from its ſlope. The water therefore which has acquired a permanent form in ſuch an aqueduct, muſt neceſſarily take that form which exactly performs the offices requiſite in its different portions. The ſurface remains horizontal in the baſon, as to KC (fig. 1.), till it comes near the entry of the canal AB, and there it acquires the form of an undulated curve CDE; and then the ſurface acquires an uniform ſlope EF, in the lower part of the canal, where the water is in train.

Plate DLXXIII. Fig. 1.

If this is a drain, the diſcharge is much leſs than might be produced by the ſame bed if this ſudden ſlope could be avoided. If it is to be navigated, having only a very gentle ſlope in its whole length, this ſudden ſlope is a very great imperfection, both by diminiſhing the depth of water, which might otherwiſe be obtained along the canal, and by rendering the paſſage of boats into the baſon very difficult, and the coming out very hazardous.

All this may be avoided, and the velocity at the entry may be kept equal to that which forms the train of the canal, by the ſimple proceſs of enlarging the entry. Suppoſe that the water could accelerate along the ſlopes of the canal, as a heavy body would do on a finely poliſhed plane. If we now make the width of the entry in its different parts inverſely proportional to the fictitious velocities in thoſe parts, it is plain that the ſlope of the ſurface will be made parallel to that of the canal which is in train. This will require a form ſomewhat like a bell or ſpeaking trumpet, as may eaſily be ſhown by a mathematical diſcuſſion. It would, however, be ſo much evaſated at the baſon as to occupy much room, and it would be very expenſive to make ſuch an excavation. But we may, at a very moderate expence of money and room, make the increaſe of velocity at the entry almoſt inſenſible. This ſhould always be done, and it is not all expence: for if it be not done, the water will undermine the banks on each ſide, becauſe it is moving very ſwiftly, and will make an excavation for itſelf, leaving all the mud in the canal below. We may obſerve this enlargement at the entry of all natural derivations from a baſon or lake. It is a very inſtructive experiment, to fill up this enlargement, continuing the parallel ſides of the drain quite to the ſide of the lake. We ſhall immediately obſerve the water grow ſhallower in the drain, and its performance will diminiſh. Suppoſing the ditch carried on with parallel ſides quite to the ſide of the baſon, if we build two walls or dykes from the extremities of thoſe ſides, bending outwards with a proper curvature (and this will often be leſs coſtly than widening the drain), the diſcharge will be greatly increaſed. We have ſeen inſtances where it was nearly doubled.

The enlargement at the mouths of rivers is generally owing to the ſame cauſe. The tide of flood up the river produces a ſuperficial ſlope oppoſite to that of the river, and this widens the mouth. This is moſt remarkable when the tides are high, and the river has little ſlope.

After this great fall at the entry of the canal, in which all the filaments are much accelerated, and the inferior ones moſt of all, things take a contrary turn. The water, by rubbing on the bottom and the ſides, is retarded; and therefore the ſection muſt, from being ſhallow, become a little deeper, and the ſurface will be convex for ſome diſtance till all comes into train. When this is eſtabliſhed, the filaments neareſt the bottom and ſide are moving ſloweſt, and the ſurface (in the middle eſpecially) retains the greateſt velocity, gliding over the reſt. The velocity in the canal, and the depth of the ſection, adjuſt themſelves in ſuch a manner that the difference between the ſurface of the baſon and the ſurface of the uniform ſection of the canal correſponds exactly to the velocity. Thus, if this be obſerved to be two feet in a ſecond, the difference of height will be $\frac{3}{10}$ths of an inch.

All the practical queſtions that are of conſiderable importance reſpecting the motion of water in aqueducts, may be eaſily, though not elegantly, ſolved by means of the tables.

But it is to be remembered, that theſe tables relate only to uniform motion, that is, to water that is in train, and where the velocity ſuffers no change by lengthening the conduit, provided the ſlope remain the ſame. It is much more difficult to determine what will be the velocity, &c. in a canal of which nothing is given but the form, and ſlope, and depth of the entry, without ſaying how deep the water runs in it. And it is here that the common doctrines of hydraulics are moſt in fault, and unable to teach us how deep the water will run in a canal, though the depth of the baſon at the entry be perfectly known. Between the part of the canal which is in train and the baſon, there is an interval where the water is in a ſtate of acceleration, and is afterwards retarded.

The determination of the motions in this interval is exceedingly

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exceedingly difficult, even in a rectangular canal. It was one great aim of M. Buat's experiments to aſcertain this by meaſuring accurately the depth of the water. But he found that when the ſlope was but a very few inches in the whole length of his canal, it was not in train for want of greater length; and when the ſlope was ſtill leſs, the ſmall fractions of an inch, by which he was to judge of the variations of depth, could not be meaſured with ſufficient accuracy. It would be a moſt deſirable point to determine the length of a canal, whoſe ſlope and other dimenſions are given, which will bring it into train; and what is the ratio which will then obtain between the depth at the entry and the depth which will be maintained. Till this be done, the engineer cannot aſcertain by a direct proceſs what quantity of water will be drawn off from a reſervoir by a given canal. But as yet this is out of our reach. Experiments, however, are in view which will promote the inveſtigation.

But this and ſimilar queſtions are of ſuch importance, that we cannot be ſaid to have improved hydraulics, unleſs we can give a tolerably preciſe anſwer. This we can do by a ſort of retrograde proceſs, proceeding on the principles of uniform motion eſtabliſhed by the Chevalier Buat. We may ſuppoſe a train maintained in the canal, and then examine whether this train *can* be produced by any fall that is poſſible at the entry. If it can, we may be certain that it is ſo produced, and our problem is ſolved.

We ſhall now point out the methods of anſwering ſome chief queſtions of this kind.

Queſt. 1. Given the ſlope s and the breadth w of a canal, and the height H of the ſurface of the water in the baſon above the bottom of the entry; to find the depth h and velocity V of the ſtream, and the quantity of water Q which is diſcharged?

The chief difficulty is to find the depth of the ſtream where it is in train. For this end, we may ſimplify the hydraulic theorem of uniform motion in N° 59. of the article RIVER; making $V=\frac{\sqrt{Ngd}}{\sqrt{S}}$, where g is the velocity (in inches) acquired in a ſecond by falling, d is the hydraulic mean depth, and $\sqrt{S}$ ſtands for $\sqrt{S}-L\sqrt{S+1.6}$ N is a number to be fixed by experiment (ſee RIVER, N° 53.) depending on the contraction or obſtruction ſuſtained at the entry of the canal, and it may in moſt common caſes be taken $=244$; ſo that $\sqrt{Ng}$ may be ſomewhat leſs than 307. To find it, we may begin by taking for our depth of ſtream a quantity h, ſomewhat ſmaller than H the height of the ſurface of the baſon above the bottom of the canal. With this depth, and the known width w of the canal, we can find the hydraulic depth d (See RIVERS, N° 48). Then with $\sqrt{d}$ and the ſlope find V by the Table: make this $V=\frac{\sqrt{Ngd}}{\sqrt{S}}$. This gives $\sqrt{Ng}=\frac{V\sqrt{S}}{\sqrt{d}}$. This value of N g is ſufficiently exact; for a ſmall error of depth hardly affects the hydraulic mean depth.

After this preparation, the expreſſion of the mean velocity in the canal will be $\frac{\sqrt{Ng}\sqrt{\frac{wh}{w+2h}}}{\sqrt{S}}$. The height which will produce this velocity is $\frac{Ng}{2GS}\left(\frac{wh}{w+2h}\right)$.

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Now this is the ſlope at the entry of the canal which produces the velocity that is afterwards maintained againſt the obſtructions by the ſlope of the canal. It is therefore $=H-h$. Hence we deduce

$$h=\frac{-\left(w\left(\frac{Ng}{2GS}+1\right)-2H\right)}{4}+\frac{\sqrt{8Hw+\left(w\left(\frac{Ng}{2GS}+1\right)-2H\right)^{2}}}{4}.$$

If there be no contraction at the entry, $g=G$ and $\frac{9}{2G}=\frac{1}{2}$.

Having thus obtained the depth h of the ſtream, we obtain the quantity of water by combining this with the width w and the velocity V.

But as this was but an approximation, it is neceſſary to examine whether the velocity V be poſſible. This is very eaſy. It muſt be produced by the fall $H-h$. We ſhall have no occaſion for any correction of our firſt aſſumption, if h has not been extravagantly erroneous, becauſe a ſmall miſtake in h produces almoſt the ſame variation in d. The teſt of accuracy, however, is, that h, together with the height which will produce the velocity V, muſt make up the whole height H. Aſſuming h too ſmall, leaves $H-h$ too great, and will give a ſmall velocity V, which requires a ſmall value of $H-h$. The error of $H-h$ therefore is always greater than the error we have committed in our firſt aſſumption. Therefore when this error of $H-h$ is but a trifle, ſuch as one-fourth of an inch, we may reſt ſatisfied with our anſwer.

Perhaps the eaſieſt proceſs may be the following: Suppoſe the whole ſtream in train to have the depth H. The velocity V obtained for this depth and ſlope by the Table requires a certain productive height u. Make $\sqrt{H+u}:H=H:h$, and h will be exceedingly near the truth. The reaſon is obvious.

Queſt. 2. Given the diſcharge (or quantity to be furniſhed in a ſecond) Q, the height H of the baſon above the bottom of the canal, and the ſlope; to find the dimenſions of the canal?

Let x and y be the depth and mean width. It is plain that the equation $\frac{Q}{xy}=\sqrt{2G}\sqrt{H-x}$ will give a value of y in terms of x. Compare this with the value of y obtained from the equation $\frac{Q}{xy}=\frac{\sqrt{Ng}}{\sqrt{S}}\sqrt{\frac{xy}{y+2x}}$. This will give an equation containing only x and known quantities. But it will be very complicated, and we muſt have recourſe to an approximation. This will be beſt underſtood in the form of an example.

Suppoſe the depth at the entry to be 18 inches, and the ſlope $\frac{1}{1000}$. Let 1200 cubic feet of water per minute be the quantity of water to be drawn off, for working machinery or any other purpoſe; and let the canal be be ſuppoſed of the beſt form, recommended in N° 69. of the article RIVER, where the baſe of the ſloping ſide is four-thirds of the height.

The ſlighteſt conſideration will ſhow us that if $\frac{V^2}{744}$ be taken for the height producing the velocity, it cannot exceed 3 inches, nor be leſs than 1. Suppoſe it $=2$, and therefore the depth of the ſtream in the canal to be 16 inches; find the mean width of the canal by the equation $w=\frac{Q}{h(\sqrt{d}-0.1\left(\frac{307}{\sqrt{S}}-0.3\right)}$, in which Q is 20 cubic feet (the 60th part of 1200), $\sqrt{S}$ is $=28.153$, $=\sqrt{1000}-\text{L}\sqrt{1000+1.6}$, and $h=16$. This gives $w=5.52$ feet. The ſection $n=7.36$ feet, and $V=32.6$ inches. This requires a fall of 1.52 inches inſtead of 2 inches. Take this from 18, and there remains 16.48, which we ſhall find not to differ one-tenth of an inch from the exact depth which the water will acquire and maintain. We may therefore be ſatisfied with aſſuming 5.36 feet as the mean width, and 3.53 feet for the width at the bottom.

This approximation proceeds on this conſideration, that when the width diminiſhes by a ſmall quantity, and in the ſame proportion that the depth increaſes, the hydraulic mean depth remains the ſame, and therefore the velocity alſo remains, and the quantity diſcharged changes in the exact proportion of the ſection. Any minute error which may reſult from this ſuppoſition, may be corrected by increaſing the fall producing the velocity, in the proportion of the firſt hydraulic mean depth to the mean depth correſponding to the new dimenſions found for the canal. It will now become 1.53, and V will be 32.72, and the depth will be 16.47. The quantity diſcharged being divided by V, will give the ſection $=7.335$ feet, from which, and the new depth, we obtain 5.344 for the width.

This and the foregoing are the moſt common queſtions propoſed to an engineer. We aſſerted with ſome confidence that few of the profeſſion are able to anſwer them with tolerable preciſion. We cannot offend the profeſſional gentlemen by this, when we inform them that the Academy of Sciences at Paris were occupied during ſeveral months with an examination of a plan propoſed by M. Parcieux, for bringing the waters of the Yvette into Paris; and after the moſt mature conſideration, gave in a report of the quantity of water which M. De Parcieux's aqueduct would yield, and that their report has been found erroneous in the proportion of at leaſt 2 to 5: For the waters have been brought in, and exceed the report in this proportion. Indeed long after the giving in the report, M. Perronet, the moſt celebrated engineer in France, affirmed that the dimenſions propoſed were much greater than were neceſſary, and ſaid that an aqueduct of $5\frac{1}{2}$ feet wide, and $3\frac{1}{2}$ deep with a ſlope of 15 inches in a thouſand fathoms, would have a velocity of 12 or 13 inches per ſecond, which would bring in all the water furniſhed by the propoſed ſources. The great diminution of expence occaſioned by the alteration encouraged the community to undertake the work. It was accordingly begun, and a part executed. The water was found to run with a velocity of near 19 inches when it was $3\frac{1}{2}$ feet deep. M. Perronet founded his computation on his own experience alone, acknowledging that he had no theory to inſtruct him. The work was carried no farther, it being found that the city could be ſupplied at a much ſmaller expence by ſteam engines erected by Boulton and Watt. But the facts which occurred in the partial execution of the aqueduct are very valuable. If M. Perronet's aqueduct be examined by our general formula, s will be found $=\frac{1}{4800}$, and $d=18.72$, from which we deduce the velocity $=18\frac{2}{3}$, agreeing with the obſervation with aſtoniſhing preciſion.

The experiments at Turin by Michaelotti on canals were very numerous, but complicated with many circumſtances which would render the diſcuſſion too long for this place. When cleared of theſe circumſtances, which we have done with ſcrupulous care, they are alſo abundantly conformable to our theory of the uniform motion of running waters. But to return to our ſubject:

Should it be required to bring off at once from the baſon a mill courſe, having a determined velocity for driving an underſhot wheel, the problem becomes eaſier, becauſe the velocity and ſlope combined determine the hydraulic mean depth at once; and the depth of the ſtream will be had by means of the height which muſt be taken for the whole depth at the entry, in order to produce the required velocity.

In like manner, having given the quantity to be diſcharged, and the velocity and the depth at the entry, we can find the other dimenſions of the channel; and the mean depth being found, we can determine the ſlope.

When the ſlope of a canal is very ſmall, ſo that the depth of the uniform ſtream differs but a little from that at the entry, the quantity diſcharged is but ſmall. But a great velocity, requiring a great fall at the entry, produces a great diminution of depth, and therefore it may not compenſate for this diminution, and the quantity diſcharged may be ſmaller. Improbable as this may appear, it is not demonſtrably falſe; and hence we may ſee the propriety of the following

Queſtion 3. Given the depth H at the entry of a rectangular canal, and alſo its width *w*; required the ſlope, depth, and velocity which will produce the greateſt poſſible diſcharge?

Let x be the unknown depth of the ſtream. $H-x$ is the productive fall, and the velocity is $\sqrt{2G}\sqrt{H-x}$. This multiplied by $w\,x$ will give the quantity diſcharged. Therefore $w\,x\sqrt{2G}\sqrt{H-x}$ muſt be made a maximum. The common proceſs for this will give the equation, $2H=3x$, or $x=\frac{2}{3}H$. The mean velocity will be $\sqrt{2G}$, $\sqrt{\frac{1}{3}H}$; the ſection will be $\frac{2}{3}wH$, and the diſcharge $=\frac{2}{3}\sqrt{2G}\,wH\sqrt{\frac{1}{3}H}$, and $d=\frac{\frac{2}{3}wH}{w+\frac{4}{3}H}$. With theſe data the ſlope is eaſily had by the formula for uniform motion.

If the canal is of the trapezoidal form, the inveſtigation is more troubleſome, and requires the reſolution of a cubic equation.

It may appear ſtrange that increaſing the ſlope of a canal beyond the quantity determined by this problem can diminiſh the quantity of water conveyed. But one of theſe two things muſt happen; either the motion will not acquire uniformity in ſuch a canal for want of length,

length, or the diſcharge muſt diminiſh. Suppoſing, however, that it could augment, we can judge how far this can go. Let us take the extreme caſe by making the canal vertical. In this caſe it becomes a ſimple weir or waſteboard. Now the diſcharge of a waſteboard is $\frac{2}{3}\sqrt{2\,\mathrm{G}}\,w\,(h^{\frac{3}{2}}—(\frac{1}{2}h)^{\frac{3}{2}}$. The maximum determined by the preceding problem is to that of the waſteboard of the ſame dimenſions as $\mathrm{H}\sqrt{\frac{1}{3}\mathrm{H}} : \mathrm{H}^{\frac{3}{2}}—(\frac{1}{2}\mathrm{H})^{\frac{3}{2}}$, or as $\mathrm{H}\sqrt{\frac{1}{3}\mathrm{H}} : \mathrm{H}\sqrt{\mathrm{H}}—\frac{1}{2}\mathrm{H}\sqrt{\frac{1}{2}\mathrm{H}}, =5773 : 6465$, nearly $= 9 : 10$.

Having given the dimenſions and ſlope of a canal, we can diſcover the relation between its expenditure and the time; or we can tell how much it will ſink the ſurface of a pond in 24 hours, and the gradual progreſs of this effect; and this might be made the ſubject of a particular problem. But it is complicated and difficult. In caſes where this is an intereſting object, we may ſolve the queſtion with ſufficient accuracy, by calculating the expenditure at the beginning, ſuppoſing the baſon kept full. Then from the known area of the pond, we can tell in what time this expenditure will ſink an inch; do the ſame on the ſuppoſition that the water is one-third lower, and that it is two-thirds lower (noticing the contraction of the ſurface of the pond occaſioned by this abſtraction of its waters). Thus we ſhall obtain three rates of diminution, from which we can eaſily deduce the deſired relation between the expenditure and the time.

Aqueducts derived from a baſon or river are commonly furniſhed with a ſluice at the entry. This changes exceedingly the ſtate of things. The ſlope of the canal may be preciſely ſuch as will maintain the mean velocity of the water which paſſes under the ſluice: in which caſe the depth of the ſtream is equal to that of the ſluice, and the velocity is produced at once by the head of water above it. But if the ſlope is leſs than this, the velocity of the iſſuing water is diminiſhed, and the water muſt riſe in the canal. This muſt check the efflux at the ſluice, and the water will be as it were ſtagnant above what comes through below it. It is extremely difficult to determine at what preciſe ſlope the water will begin to check the efflux. The contraction at the lower edge of the board hinders the water from attaining at once the whole depth which it acquires afterwards, when its velocity diminiſhes by the obſtructions. While the regorging which theſe obſtructions occaſion does not reach back to the ſluice, the efflux is not affected by it.—Even when it does reach to the ſluice, there will be a leſs depth immediately behind it than farther down the canal, where it is in train; becauſe the ſwift moving water which is next the bottom drags with it the regorged water which lies on it: but the canal muſt be rapid to make this difference of depth ſenſible. In ordinary canals, with moderate ſlopes and velocities, the velocity at the ſluice may be ſafely taken as if it were that which correſponds to the difference of depths above and below the ſluice, where both were in train.

Let therefore H be the depth above the ſluice, and h the depth in the canal. Let e be the elevation of the ſluice above the ſole, and let b be its breadth. The diſcharge will be $e\,b\sqrt{\mathrm{H}—h}\,\sqrt{2\,\mathrm{G}}$ for the ſluice, and $w\,h\frac{\sqrt{\mathrm{N}g}}{\sqrt{s}}\sqrt{\frac{w\,h}{w+2\,h}}$ for the canal. Theſe muſt be the ſame. This gives the equation $e\,b\sqrt{\mathrm{H}—h}\,\sqrt{2\,\mathrm{G}} = w\,h\frac{\sqrt{\mathrm{N}g}}{\sqrt{s}}\sqrt{\frac{w\,h}{w+2\,h}}$ containing the ſolution of all the queſtions which can be propoſed. The only uncertainty is in the quantity G, which expreſſes the velocity competent to the paſſage of the water through the orifice, circumſtanced as it is, namely, ſubjected to contraction. This may be regulated by a proper form given to the entry into this orifice. The contraction may be almoſt annihilated by making the maſonry of a cycloidal form on both ſides, and alſo at the lower edge of the ſluice-board, ſo as to give the orifice a form reſembling fig. 5. D, in the article RIVERS. If the ſluice is thin in the face of a baſon, the contraction will reduce 2 G to 296. If the ſluice be as wide as the canal, 2 G will be nearly 500.

Queſtion 4. Given the head of water in the baſon H, the breadth b, and elevation e of the ſluice, and the breadth w and ſlope s of the canal, to find the depth h of the ſtream, the velocity, and the diſcharge?

We muſt (as in *Queſtion* 2.) make a firſt ſuppoſition for h, in order to find the proper value of d. Then the equation $e\,b\sqrt{\mathrm{H}—h}\,\sqrt{2\,\mathrm{G}} = w\,h\frac{\sqrt{\mathrm{N}g}}{\sqrt{s}}$ gives $h = \frac{\mathrm{G}\,e^2\,b^2\,s}{w^2\,\mathrm{N}g\,d} + \sqrt{\frac{\mathrm{G}\,e^2\,b^2\,s\,\mathrm{H}}{w^2\,\mathrm{N}g\,d} + \left(\frac{\mathrm{G}\,e^2\,b^2\,s}{w^2\,\mathrm{N}g\,d}\right)^2}$. If this value ſhall differ conſiderably from the one which we aſſumed in order to begin the computation, make uſe of it for obtaining a new value of d, and repeat the operation. We ſhall rarely be obliged to perform a third operation.

The following is of frequent uſe:

Queſtion 5. Given the dimenſions and the ſlope, with the velocity and diſcharge of a river in its ordinary ſtate, required the area or ſection of the ſluice which will raiſe the waters to a certain height, ſtill allowing the ſame quantity of water to paſs through? Such an operation may render the rivers navigable for ſmall craft or rafts above the ſluice.

The problem is reduced to the determination of the ſize of orifice which will diſcharge this water with a velocity competent to the height to which the river is to be raiſed; only we muſt take into conſideration the velocity of the water above the ſluice, conſidering it as produced by a fall which makes a part of the height productive of the whole velocity at the ſluice. Therefore H, in our inveſtigation, muſt conſiſt of the height to which we mean to raiſe the waters, and the height which will produce the velocity with which the waters approach the ſluice: h, or the depth of the ſtream, is the ordinary depth of the river. Then (uſing the former ſymbols) we have $e\,b\,\frac{w\,h\sqrt{\mathrm{N}g\,d},}{\sqrt{2\,\mathrm{G}\,s\,(\mathrm{H}—h)}}, = \frac{\mathrm{Q}}{\sqrt{2\,\mathrm{G}\,(\mathrm{H}—h)}}$.

If the area of the ſluice is known, and we would learn the height to which it will raiſe the river, we have $\mathrm{H}—h = \frac{\mathrm{Q}^2}{2\,\mathrm{G}\,e^2\,b^2}$ for the expreſſion of the riſe of the

water

water above its ordinary level. But from this we muſt take the height which would produce the velocity of the river; ſo that if the ſluice were as wide as the river, and were raiſed to the ordinary ſurface of the water, $\frac{Q^2}{2\,G\,e^2\,b^2}$, which expreſſes the height that produces the velocity under the ſluice, muſt be equal to the depth of the river, and $H-h$ will be $=0$.

The performance of aqueduct drains is a very important thing, and merits our attention in this place. While the art of managing waters, and of conducting them ſo as to anſwer our demands, renders us very important ſervice by embelliſhing our habitations, or promoting our commercial intercourſe, the art of draining creates as it were new riches, fertilizing tracts of bog or marſh, which was not only uſeleſs, but hurtful by its unwholeſome exhalations, and converting them into rich paſtures and gay meadows. A wild country, occupied by marſhes which are inacceſſible to herds or flocks, and ſerve only for the haunts of water-fowls, or the retreat of a few poor fiſhermen, when once it is freed from the waters in which it is drowned, opens its lap to receive the moſt precious ſeeds, is ſoon clothed in the richeſt garb, gives life and abundance to numerous herds, and never fails to become the delight of the induſtrious cultivator who has enfranchiſed it, and is attached to it by the labour which it coſt him. In return, it procures him abundance, and ſupplies him with the means of daily augmenting its fertility. No ſpecies of agriculture exhibits ſuch long-continued and progreſſive improvement. New families flock to the ſpot, and there multiply; and there nature ſeems the more eager to repay their labours, in proportion as ſhe has been obliged, againſt her will, to keep her treaſures locked up for a longer time, chilled by the waters. The countries newly inhabited by the human race, as is a great part of America, eſpecially to the ſouthward, are ſtill covered to a great extent with marſhes and lakes; and they would long remain in this condition, if population, daily making new advances, did not increaſe induſtry, by multiplying the cultivating hands, at the ſame time that it increaſes their wants. The Author of this beautiful world has at the beginning formed the great maſſes of mountain, has ſcooped out the dales and ſloping hills, has traced out the courſes, and even formed the beds of the rivers: but he has left to man the care of making his place of abode, and the field which muſt feed him, dry and comfortable. For this taſk is not beyond his powers, as the others are. Nay, by having this given to him in charge, he is richly repaid for his labour by the very ſtate in which he finds thoſe countries into which he penetrates for the firſt time. Being covered with lakes and foreſts, the juices of the ſoil are kept for him as it were in reſerve. The air, the burning heat of the ſun, and the continual waſhing of rains, would have combined to expend and diſſipate their vegetative powers, had the fields been expoſed in the ſame degree to their action as the inhabited and cultivated countries, the moſt fertile moulds of which are long ſince lodged in the bottom of the ocean. All this would have been completely loſt through the whole extent of South America, had it not been protected by the foreſts which man muſt cut down, by the rank herbage which he muſt burn, and by the marſh and bog which he muſt deſtroy by draining. Let not ungrateful man complain of this. It is his duty to take on himſelf the taſk of opening up treaſures, preſerved on purpoſe for him with ſo much judgement and care. If he has diſcernment and ſenſibility, he will even thank the Author of all good, who has thus huſbanded them for his uſe. He will co-operate with his beneficent views, and will be careful not to proceed by wantonly ſnatching at preſent any partial good, and by picking out what is moſt eaſily got at, regardleſs of him who is to come afterwards to uncover and extract the remaining riches of the ground. A wiſe adminiſtration of ſuch a country will think it their duty to leave a juſt ſhare of this inheritance to their deſcendants, who are entitled to expect it as the laſt legatees. National plans of cultivation ſhould be formed on this principle, that the ſteps taken by the preſent cultivators for realizing part of the riches of the infant country ſhall not obſtruct the works which will afterwards be neceſſary for alſo obtaining the remainder. This is carefully attended to in Holland and in China. No man is allowed to conduct the drains, by which he recovers a piece of marſh, in ſuch a way as to render it much more difficult for a neighbour, or even for his own ſucceſſor, to drain another piece, although it may at preſent be quite inacceſſible. There remains in the middle of the moſt cultivated countries many marſhes, which induſtry has not yet attempted to drain, and where the legiſlature has not been at pains to prevent many little abuſes which have produced elevations in the beds of rivers, and rendered the complete draining of ſome ſpots impoſſible. Adminiſtration ſhould attend to ſuch things, becauſe their conſequences are great. The ſciences and arts, by which alone theſe difficult and coſtly jobs can be performed, ſhould be protected, encouraged, and cheriſhed. It is only from ſcience that we can obtain principles to direct theſe arts. The problem of draining canals is one of the moſt important, and yet has hardly ever occupied the attention of the hydraulic ſpeculatiſt. We apprehend that M. Buat's theory will throw great light on it; and regret that the very limited condition of our preſent work will hardly afford room for a ſlight ſketch of what may be done on the ſubject. We ſhall, however, attempt it by a general problem, which will involve moſt of the chief circumſtances which occur in works of that kind.

Queſt. 6. Let the hollow ground A (fig. 2.) be inundated by rains or ſprings, and have no outlet but the canal AB, by which it diſcharges its water into the neighbouring river BCDE, and that its ſurface is nearly on a level with that of the river at B. It can only drain when the river ſinks in the droughts of ſummer; and even if it could then drain completely, the putrid marſh would only be an infecting neighbour. It may be propoſed to drain it by one or more canals; and it is required to determine their lengths and other dimenſions, ſo as to produce the beſt effects? Fig. 2.

It is evident that there are many circumſtances to determine the choice, and many conditions to be attended to.

If the canals AC, AD. AG, are reſpectively equal to the portions BC, BD, BE, of the river, and have the ſame ſlopes, they will have the ſame diſcharge; but they are not for this reaſon equivalent. The long canal AE may drain the marſh completely, while the ſhort one AC will only do it in part; becauſe the difference of level between A and C is but inconſiderable. Alſo the freſhes of the river may totally obſtruct the operation of AC, while the canal AE cannot be hurt by them, E being ſo much lower than C. Therefore the canal muſt be carried ſo far down the river, that no freſhes there ſhall ever raiſe the waters in the canal ſo high as to reduce the ſlope in the upper part of it to ſuch a level that the current ſhall not be ſufficient to carry off the ordinary produce of water in the marſh.

Still the problem is indeterminate, admitting many ſolutions. This requiſite diſcharge may be accompliſhed by a ſhort but wide canal, or by a longer and narrower. Let us firſt ſee what ſolution can be made, ſo as to accompliſh our purpoſe in the moſt economical manner, that is, by means of the ſmalleſt equation.—We ſhall give the ſolution in the form of an example.

Suppoſe that the daily produce of rains and ſprings raiſes the water $1\frac{1}{2}$ inch on an area of a ſquare league, which gives about 120,000 cubic fathoms of water. Let the bottom of the baſon be three feet below the ſurface of the freſhes in the river at B in winter. Alſo, that the ſlope of the river is 2 inches in 100 fathoms, or $\frac{1}{3600}$dth, and that the canal is to be 6 feet deep.

The canal being ſuppoſed nearly parallel to the river, it muſt be at leaſt 1800 fathoms long before it can be admitted into the river, otherwiſe the bottom of the bog will be lower than the mouth of the canal; and even then a hundred or two more fathoms added to this will give it ſo little ſlope, that an immenſe breadth will be neceſſary to make the diſcharge with ſo ſmall a velocity. On the other hand, if the ſlope of the canal be made equal to that of the river, an extravagant length will be neceſſary before its admiſſion into the river, and many obſtacles may then intervene. And even then it muſt have a breadth of 13 feet, as may eaſily be calculated by the general hydraulic theorem. By receding from each of theſe extremes, we ſhall diminiſh the expence of excavation. Therefore,

Let x and y be the breadth and length, and h the depth (6 feet), of the canal. Let q be the depth of the bog below the ſurface of the river, oppoſite to the baſon, D the diſcharge in a ſecond, and $\frac{1}{a}$ the ſlope of the river. We muſt make $h\,x\,y$ a minimum, or $x\dot{y}+y\dot{x}=0$.

The general formula gives the velocity

$$V=\frac{\sqrt{ng}\,(\sqrt{d}-0,1)}{\sqrt{s}-L\sqrt{s+1,6}}-0,3\,(\sqrt{d}-0,1).$$

This would give x and y; but the logarithmic term renders it very complicated. We may make uſe of the ſimple form $V=\frac{\sqrt{Ngd}}{\sqrt{S}}$, making $\sqrt{Ng}$ nearly $2\,y\,b$. This will be ſufficiently exact for all caſes which do not deviate far from this, becauſe the velocities are very nearly in the ſubduplicate ratio of the ſlopes.

To introduce theſe data into the equation, recollect that $V=\frac{D}{hx}$; $d=\frac{hx}{x+2h}$. As to S, recollect that the canal being ſuppoſed of nearly equal length with the river, $\frac{y}{a}$ will expreſs the whole difference of height, and $\frac{y}{a}-q$ is the difference of height for the canal. This quantity being divided by y, gives the value of $\frac{1}{S}=\frac{\frac{y}{a}-q}{y}$. Therefore the equation for the canal becomes $\sqrt{Ng}\sqrt{\frac{hx}{x+2h}}\sqrt{\frac{\frac{y}{a}-q}{y}}$. Hence we deduce

$$y=\frac{Ngqh^3x^3}{\frac{Ngh^3x^3}{a}-D^2(x+2h)}\text{ and }\dot{y}=\frac{3Ngqh^3x^2\dot{x}}{\frac{Ngh^3x^3}{a}-D^2(x+2h)}$$

$$-\frac{Ngqh^3x^3\dot{x}\left(\frac{3Ngh^3x^2}{a}-D^2\right)}{\left.\frac{Ngh^3x^3}{a}-D^2(x+2h)\right)^2}.$$

If we ſubſtitute theſe values in the equation $y\dot{x}+x\dot{y}=0$, and reduce it, we obtain finally,

$$\frac{Ngh^3x^3}{aD^2}-3x=8h.$$

If we reſolve this equation by making $Ng=(296)^2$, or 87616 inches; $h=72$, $\frac{1}{a}=\frac{1}{3600}$, and $D=518400$, we obtain $x=392$ inches, or 32 feet 8 inches, and $\frac{D}{hx}$, or $V=18,36$ inches. Now putting theſe values in the exact formula for the velocity, we obtain the ſlope of the canal, which is $\frac{1}{11604}$, nearly 0,62, inches in 100 fathoms.

Let l be the length of the canal in fathoms. As the river has 2 inches fall in 100 fathoms, the whole fall is $\frac{2\,l}{100}$ and that of the canal is $\frac{0,62\,l}{100}$. The difference of theſe two muſt be 3 feet, which is the difference between the river and the entry of the canal. We have therefore $\left(\frac{2-0,62}{100}\right)l=36$ inches. Hence $l=2604$ fathoms; and this multiplied by the ſection of the canal gives 14177 cubic fathoms of earth to be removed.

This may ſurely be done, in moſt caſes, for eight ſhillings each cubic fathom, which does not amount to 6000l. a very moderate ſum for completely draining of nine ſquare miles of country.

In order to judge of the importance of this problem, we have added two other canals, one longer and the other ſhorter, having their widths and ſlopes ſo adjuſted as to enſure the ſame performance.

Width. Feet.	Velocity. Inches.	Slope.	Length.	Excavation.
42	14.28	$\frac{1}{18718}$	2221	15547
$32\frac{2}{3}$	18.36	$\frac{1}{11604}$	2604	14177
21	28.57	$\frac{1}{4761}$	7381	25833

We have conſidered this important problem in its moſt ſimple ſtate. If the baſon is far from the river, ſo that the drains are not nearly parallel to it, and therefore have leſs ſlope attainable in their courſe, it is more difficult. Perhaps the beſt method is to try two very extreme caſes and a middle one, and then a fourth, nearer to that extreme which differs leaſt from the middle one in the

the quantity of excavation. This will point out on which ſide the minimum of excavation lies, and alſo the law by which it diminiſhes and afterwards increaſes. Then draw a line, on which ſet off from one end the lengths of the canals. At each length erect an ordinate repreſenting the excavation; and draw a regular curve through the extremities of the ordinates. From that point of the curve which is neareſt to the baſe line, draw another ordinate to the baſe. This will point out the beſt length of the canal with ſufficient accuracy. The length will determine the ſlope, and this will give the width, by means of the general theorem. *N. B.* Theſe draining canals muſt always come off from the baſon with evaſated entries. This will prevent the loſs of much fall at the entry.

Two canals may ſometimes be neceſſary. In this caſe expence may frequently be ſaved, by making one canal flow into the other. This, however, muſt be at ſuch a diſtance from the baſon, that the ſwell produced in the other by this addition may not reach back to the immediate neighbourhood of the baſon, otherwiſe it would impede the performance of both. For this purpoſe, recourſe muſt be had to Problem III. in N° 104. of the article River. We muſt here obſerve, that in this reſpect canals differ exceedingly from rivers; rivers enlarge their beds, ſo as always to convey every increaſe of waters; but a canal may be gorged through its whole length, and will then greatly diminiſh its diſcharge. In order that the lower extremity of a canal may convey the waters of an equal canal admitted into it, their junction muſt be ſo far from the baſon, that the ſwell occaſioned by raiſing its waters nearly $\frac{1}{2}$ more (viz. in the ſubduplicate ratio of 1 to 2) may not reach back to the baſon.

This obſervation points out another method of economy. Inſtead of one wide canal, we may make a narrower one of the whole length, and another narrow one reaching part of the way. and communicating with the long canal at a proper diſtance from the baſon. But the lower extremity will now be too ſhallow to convey the waters of both. Therefore raiſe its banks by uſing the earth taken from its bed, which muſt at any rate be diſpoſed of. Thus the waters will be conveyed, and the expence, even of the lower part of the long canal, will ſcarcely be increaſed.

Theſe obſervations muſt ſuffice for an account of the management of open canals; and we proceed to the conſideration of the conduct of water in pipes.

This is much more ſimple and regular, and the general theorem requires very trifling modifications for adapting it to the caſes or queſtions that occur in the practice of the civil engineer. Pipes are always made round, and therefore d is always $\frac{1}{4}$th of the diameter. The velocity of water in a pipe which is in train, is

$$= V, = \frac{307(\sqrt{d} - 0,1)}{\sqrt{s} - L\sqrt{s+1,6}} - 0,3\,(\sqrt{d} - 0,) \text{ or} = (\sqrt{d} - 0,1)\left(\frac{307}{\sqrt{s} - L\sqrt{s+1,6}} - 0,3\right).$$

The chief queſtions are the following:

Queſt 1. Given the height H of the reſervoir above the place of delivery, and the diameter and length of the pipe, to find the quantity of water diſcharged in a ſecond?

Let L be the length, and h the fall which would produce the velocity with which the water enters the pipe, and actually flows in it, after overcoming all obſtructions. This may be expreſſed in terms of the velocity by $\frac{V^2}{2G}$, G denoting the acceleration of gravity, correſponding to the manner of entry. When no methods are adopted for facilitating the entry of the water, by a bell-ſhaped funnel or otherwiſe, 2 G may be aſſumed as = 500 inches, or 42 feet, according as we meaſure the velocity in inches or feet. The ſlope is $\frac{1}{s}, = \frac{H - \frac{V^2}{2G}}{L}$, which muſt be put into the general formula. This would make it very complicated. We may ſimplify it by the conſideration that the velocity is very ſmall in compariſon of that ariſing from the height H: conſequently h is very ſmall. Alſo, in the ſame pipe, the reſiſtances are nearly in the duplicate ratio of the velocities when theſe are ſmall, and when they differ little among themſelves. Therefore make $b = \frac{L}{h}$, taking h by gueſs, a very little leſs than H. Then compute the mean velocity v correſponding to theſe data, or take it from the table. If $h + \frac{v^2}{2G}$ be = H, we have found the mean velocity $V = v$. If not, make the following proportion:

$$h : \frac{v^2}{2G} = H - \frac{V^2}{2G} : \frac{V^2}{2G},$$

which is the ſame with this, $h + \frac{v^2}{2G} : v^2 = H : V^2$, and V^2 is $= \frac{v^2\,H}{h + \frac{v^2}{2G}}, = \frac{v^2\,H}{\frac{2Gh + v^2}{2G}}, = \frac{v^2 \cdot 2GH}{v^2 + 2Gh}.$

If the pipe has any bendings, they muſt be calculated for in the manner mentioned in the article River, N° 101; and the head of water neceſſary for overcoming this additional reſiſtance being called $\frac{V^2}{m}$, the laſt proportion muſt be changed for

$$h + v^2\left(\frac{1}{2G} + \frac{1}{m}\right) : v^2 = H : V^2.$$

Queſt. 2. Given the height of the reſervoir, the length of the pipe, and the quantity of water which is to be drawn off in a ſecond; to find the diameter of the pipe which will draw it off?

Let d be conſidered as $= \frac{1}{4}$th of the diameter, and let $1 : c$ repreſent the ratio of the diameter of a circle to its circumference. The ſection of the pipe is $4cd^2$. Let the quantity of water per ſecond be Q; then $\frac{Q}{4cd^2}$ is the mean velocity. Divide the length of the pipe by the height of the reſervoir above the place of delivery, diminiſhed by a very ſmall quantity, and call the quotient S. Conſider this as the ſlope of the conduit; the general formula now becomes

$$\frac{Q}{4d^2} = \frac{307(\sqrt{d} - 0.1)}{\sqrt{s} - L\sqrt{s+1,06}} - 0,3\,(\sqrt{d} - 0,1), \text{ or}$$

$$\frac{Q}{4cd^2}$$

$\frac{Q}{4cd^2}=\frac{(307(\sqrt{d}--0,1)}{\sqrt{S}}-0,3\,(\sqrt{d}-0,1)$. We may neglect the laſt term in every caſe of civil practice, and alſo the ſmall quantity 0,1. This gives the very ſimple formula,

$$\frac{Q}{4cd^2}=\frac{307\sqrt{d}}{\sqrt{S}}$$

from which we readily deduce

$$d=\overline{\frac{Q\sqrt{S}}{4c\times 307}}\Big|^{\frac{2}{5}}=\overline{\frac{Q\sqrt{S}}{3858}}\Big|^{\frac{2}{5}}$$

This proceſs gives the diameter ſomewhat too ſmall. But we eaſily rectify this error by computing the quantity delivered by the pipe, which will differ a little from the quantity propoſed. Then obſerving, by this equation, that two pipes having the ſame length and the ſame ſlope give quantities of water, of which the ſquares are nearly as the fifth powers of the diameter, we form a new diameter in this proportion, which will be almoſt perfectly exact.

It may be obſerved that the height aſſumed for determining the ſlope in theſe two queſtions will ſeldom differ more than an inch or two from the whole height of the reſervoir above the place of delivery; for in conduits of a few hundred feet long, the velocity ſeldom exceeds four feet per ſecond, which requires only a head of three inches.

As no inconvenience worth minding reſults from making the pipes a tenth of an inch or ſo wider than is barely ſufficient, and as this generally is more than the error ariſing from even a very erroneous aſſumption of *h*, the anſwer firſt obtained may be augmented by one or two tenths of an inch, and then we may be confident that our conduit will draw off the intended quantity of water.

We preſume that every perſon who aſſumes the name of engineer knows how to reduce the quantity of water meaſured in gallons, pints, or other denominations, to cubic inches, and can calculate the gallons, &c. furniſhed by a pipe of known diameter, moving with a velocity that is meaſured in inches per ſecond. We farther ſuppoſe that all care is taken in the conſtruction of the conduit, to avoid obſtructions occaſioned by lumps of ſolder hanging in the inſide of the pipes; and, particularly, that all the cocks and plugs by the way have waterways equal to the ſection of the pipe. Undertakers are moſt tempted to fail here, by making the cocks too ſmall, becauſe large cocks are very coſtly. But the employer ſhould be ſcrupulouſly attentive to this; becauſe a ſimple contraction of this kind may be the throwing away of many hundred pounds in a wide pipe, which yields no more water than can paſs through the ſmall cock.

The chief obſtructions ariſe from the depoſition of ſand or mud in the lower parts of pipes, or the collection of air in the upper parts of their bendings. The velocity being always very moderate, ſuch depoſitions of heavy matters are unavoidable. The utmoſt care ſhould therefore be taken to have the water freed from all ſuch things at its entry by proper filtration; and there ought to be cleanſing plugs at the lower parts of the bendings, or rather a very little way beyond them. When theſe are opened, the water iſſues with greater velocity, and carries the depoſitions with it.

It is much more difficult to get rid of the air which chokes the pipes by lodging in their upper parts. This is ſometimes taken in along with the water at the reſervoir, when the entry of the pipe is too near the ſurface. This ſhould be carefully avoided, and it coſts no trouble to do ſo. If the entry of the pipe is two feet under the ſurface, no air can ever get in. Floats ſhould be placed above the entries, having lids hanging from them, which will ſhut the pipe before the water runs too low,

But air is alſo diſengaged from ſpring-water by merely paſſing along the pipe. When pipes are ſupplied by an engine, air is very often drawn in by the pumps in a diſengaged ſtate. It is alſo diſengaged from its ſtate of chemical union, when the pumps have a ſuction-pipe of 10 or 12 feet, which is very common. In whatever way it is introduced, it collects in all the upper part of bendings, and chokes the paſſage, ſo that ſometimes not a drop of water is delivered. Our cocks ſhould be placed there, which ſhould be opened frequently by perſons who have this in charge. Deſaguliers deſcribes a contrivance to be placed on all ſuch eminences, which does this of itſelf. It is a pipe with a cock, terminating in a ſmall ciſtern. The key of the cock has a hollow ball of copper at the end of a lever. When there is no air in the main pipe, water comes out by this diſcharger, fills the ciſtern, raiſes the ball, and thus ſhuts the cock. But when the bend of the main contains air, it riſes into the ciſtern, and occupies the upper part of it. Thus the floating ball falls down, the cock opens and lets out the air, and the ciſtern again filling with water, the ball riſes, and the cock is again ſhut.

A very neat contrivance for this purpoſe was invented by the late Profeſſor Ruſſel of Edinburgh. The cylindrical pipe BCDE (fig. 3.), at the upper end of a bending of the main, is ſcrewed on, the upper end of which is a flat plate perforated with a ſmall hole F. This pipe contains a hollow copper cylinder G, to the upper part of which is faſtened a piece of ſoft leather H. When there is air in the pipe, it comes out by the hole A, and occupies the diſcharger, and then eſcapes through the hole F. The water follows, and, riſing in the diſcharger, lifts up the hollow cylinder G, cauſing the leather H to apply itſelf to the plate CD, and ſhut the hole. Thus the air is diſcharged without the ſmalleſt loſs of water.

Fig. 3.

It is of the moſt material conſequence that there be no contraction in any part of a conduit. This is evident; but it is alſo prudent to avoid all unneceſſary enlargements. For when the conduit is full of water moving along it, the velocity in every ſection is inverſely proportional to the area of the ſection: it is therefore diminiſhed wherever the pipe is enlarged; but it muſt again be increaſed where the pipe contracts. This cannot be without expending force in the acceleration. This conſumes part of the impelling power, whether this be a head of water, or the force of an engine. See what is ſaid on this ſubject in the article PUMPS, N° 83, &c. Nothing is gained by any enlargement; and every contraction, by requiring an augmentation of velocity, employs a part of the impelling force preciſely equal to the weight of a column of water whoſe baſe is the contracted paſſage, and whoſe height is the fall which would produce a velocity equal to this augmentation. This point ſeems to have been quite overlooked by engineers of the firſt eminence, and has in many inſtances greatly

greatly diminiſhed the performance of their beſt works. It is no leſs detrimental in open canals; becauſe at every contraction a ſmall fall is required for reſtoring the velocity loſt in the enlargement of the canal, by which the general ſlope and velocity are diminiſhed. Another point which muſt be attended to in the conducting of water is, that the motion ſhould not be ſubſultory, but continuous. When the water is to be driven along a main by the ſtrokes of a reciprocating engine, it ſhould be forced into an air-box, the ſpring of which may preſerve it in motion along the whole ſubſequent main. If the water is brought to reſt at every ſucceſſive ſtroke of the piſton, the whole maſs muſt again be put in motion through the whole length of the main. This requires the ſame uſeleſs expenditure of power as to communicate this motion to as much dead matter; and this is over and above the force which may be neceſſary for raiſing the water to a certain height; which is the only circumſtance that enters into the calculation of the power of the pump-engine.

An air-box removes this imperfection, becauſe it keeps up the motion during the returning ſtroke of the piſton. The compreſſion of the air by the active ſtroke of the piſton muſt be ſuch as to continue the impulſe in oppoſition to the contrary preſſure of the water (if it is to be raiſed to ſome height), and in oppoſition to the friction or other reſiſtances which ariſe from the motion that the water really acquires. Indeed a very conſiderable force is employed here alſo in changing the motion of the water, which is forced out of the capacious air-box into the narrow pipe; and when this change of motion is not judiciouſly managed, the expenditure of power may be as great as if all were brought to reſt and again put into motion. It may even be greater, by cauſing the water to move in the oppoſite direction to its former motion. Of ſuch conſequence is it to have all theſe circumſtances ſcientifically conſidered. It is in ſuch particulars, unheeded by the ordinary herd of engineers or pump-makers, that the ſuperiority of an intelligent practitioner is to be ſeen.

Another material point in the conduct of water in pipes is the diſtribution of it to the different perſons who have occaſion for it. This is rarely done from the riſing main. It is uſual to ſend the whole into a ciſtern, from which it is afterwards conducted to different places in ſeparate pipes. Till the diſcovery of the general theorem by the chevalier Buat, this has been done with great inaccuracy. Engineers think that the different purchaſers from water-works receive in proportion to their reſpective bargains when they give them pipes whoſe areas are proportional to theſe payments. But we now ſee, that when theſe pipes are of any conſiderable length, the waters of a larger pipe run with a greater velocity than thoſe of a ſmaller pipe having the ſame ſlope. A pipe of two inches diameter will give much more water than four pipes of one inch diameter; it will give as much as five and a half ſuch pipes, or more; becauſe the ſquares of the diſcharges are very nearly as the fifth powers of the diameters. This point ought therefore to be carefully conſidered in the bargains made with the proprietors of water-works, and the payments made in this proportion. Perhaps the moſt unexceptionable method would be to make a double diſtribution. Let the water be firſt let off in its proper proportions into a ſecond ſeries of ſmall ciſterns, and let each have a pipe which will convey the whole water that is diſcharged into it. The firſt diſtribution may be made entirely by pipes of one inch in diameter; this would leave nothing to the calculation of the diſtributor, for every man would pay in proportion to the number of ſuch pipes which run into his own ciſtern.

In many caſes, however, water is diſtributed by pipes derived from a main. And here another circumſtance comes into action. When water is paſſing along a pipe, its preſſure on the ſides of the pipe is diminiſhed by its velocity; and if a pipe is now derived from it, the quantity drawn off is alſo diminiſhed in the ſubduplicate ratio of the preſſures. If the preſſure is reduced to one-fourth, one-ninth, one-ſixteenth, &c. the diſcharge from the lateral pipe is reduced to one-half, one-third, one-fourth, &c.

It is therefore of great importance to determine, what this diminution of preſſure is which ariſes from the motion along the main.

It is plain, that if the water ſuffered no reſiſtance in the main, its velocity would be that with which it entered, and it would paſs along without exerting any preſſure. If the pipe were ſhut at the end, the preſſure on the ſides would be the full preſſure of the head of water. If the head of water remain the ſame, and the end of the tube be contracted, but not ſtopped entirely, the velocity in the pipe is diminiſhed. If we would have the velocity in the pipe with this contracted mouth augmented to what it was before the contraction was made, we muſt employ the preſſure of a piſton, or of a head of water. This is propagated through the fluid, and thus a preſſure is immediately excited on the ſides of the pipe. New obſtructions of any kind, ariſing from friction or any other cauſe, produce a diminution of velocity in the pipe. But when the natural velocity is checked, the particles react on what obſtructs their motion; and this action is uniformly propagated through a perfect fluid in every direction. The reſiſtance therefore which we thus aſcribe to friction, produces the ſame lateral preſſure, which a contraction of the orifice, which equally diminiſhes the velocity in the pipe, would do. Indeed this is demonſtrable from any diſtinct notions that we can form of theſe obſtructions. They proceed from the want of perfect ſmoothneſs, which obliges the particles next the ſides to move in undulated lines. This excites tranſverſe forces in the ſame manner as any conſtrained curvilineal motion. A particle in its undulated path tends to eſcape from it, and acts on the lateral particles in the ſame manner that it would do if moving ſingly in a capillary tube having the ſame undulations; it would preſs on the concave ſide of every ſuch undulation. Thus a preſſure is exerted among the particles, which is propagated to the ſides of the pipe; or the diminution of velocity may ariſe from a viſcidity or want of perfect fluidity. This obliges the particle immediately preſſed to drag along with it another particle which is withheld by adheſion to the ſides. This requires additional preſſure from a piſton, or an additional head of water; and this preſſure alſo is propagated to the ſides of the pipe.

Hence it ſhould follow, that the preſſure which water in motion exerts on the ſides of its conduit is equal to that which is competent to the head of water which impels it into the pipe, diminiſhed by the head of water competent to the actual velocity with which it moves along the pipe. Let H repreſent the head of water which impels it into the entry of the pipe, and h the head which would produce the actual velocity; then $H—h$ is the column which would produce the preſſure exerted on its ſides.

This is abundantly verified by very ſimple experiments. Let an upright pipe be inſerted into the ſide of the main pipe. When the water runs out by the mouth of the main, it will riſe in this branch till the weight of the column balances the preſſure that ſupports it; and if we then aſcertain the velocity of the iſſuing water by means of the quantity diſcharged, and compute the head or height neceſſary for producing this velocity, and ſubtract this from the height of water above the entry of the main, we ſhall find the height in the branch preciſely equal to their difference. Our readers may ſee this by examining the experiments related by Graveſande, and ſtill better by conſulting the experiments narrated by Boſſut, § 558, which are detailed with great minuteneſs; the reſults correſponded accurately with this propoſition. The experiments indeed were not heights of water ſupported by this preſſure, but water expelled by it through the ſame orifice. Indeed the truth of the propoſition appears in every way we can conſider the motion of water. And as it is of the firſt importance in the practice of conducting water (for reaſons which will preſently appear), it merits a particular attention. When an inclined tube is in train, the accelerating power of the water (or its weight diminiſhed in the proportion of the length of the oblique column to its vertical height, or its weight multiplied by the fraction $\frac{1}{s}$, which expreſſes the ſlope), is in equilibrio with the obſtructions; and therefore it exerts no preſſure on the pipe but what ariſes from its weight alone. Any part of it would continue to ſlide down the inclined plane with a conſtant velocity, though detached from what follows it. It therefore derives no preſſure from the head of water which impelled it into the pipe. The ſame muſt be ſaid of a horizontal pipe infinitely ſmooth, or oppoſing no reſiſtance. The water would move in this pipe with the full velocity due to the head of water which impels it into the entry. But when the pipe oppoſes an obſtruction, the head of water is greater than that which would impel it into the pipe with the velocity that it actually has in it; and this additional preſſure is propagated along the pipe, where it is balanced by the actual reſiſtance, and therefore excites a *quaqua verſum* preſſure on the pipe. In ſhort, whatever part of the head of water in the reſervoir, or of the preſſure which impels it along the tube, is not employed in producing velocity, is employed in acting againſt ſome obſtruction, and excites (by the reaction of this obſtruction) an equal preſſure on the tube. The rule therefore is general, but is ſubject to ſome modifications which deſerve our attention.

Fig. 4.

In the ſimply inclined pipe BC (fig. 4.), the preſſure on any point S is equal to that of the head AB of water which impels the water into the pipe, wanting or *minus* that of the head of water which would communicate to it the velocity with which it actually moves. This we ſhall call x, and conſider it as the weight of a column of water whoſe length alſo is x. In like manner H may be the column AB, which impels the water into the pipe, and would communicate a certain velocity; and h may repreſent the column which would communicate the actual velocity. We have therefore $x = H—h$.

In the pipe HIKL, the preſſure at the point I is $AH—h—IO, = H—h—IO$; and the preſſure at K is $H—h+PK$.

And in the pipe DEFG, the preſſure on E is $= AR—h—EM, = H—h—EM$; and the preſſure at F is $H—h+FN$.

We muſt carefully diſtinguiſh this preſſure on any ſquare inch of the pipe from the obſtruction or reſiſtance which that inch actually exerts, and which is part of the cauſe of this preſſure. The preſſure is (by the laws of hydroſtatics) the ſame with that exerted on the water by a ſquare inch of the piſton or forcing head of water. This muſt balance the united obſtructions of the whole pipe, in as far as they are not balanced by the relative weight of the water in an encloſed pipe. Whatever be the inclination of a pipe, and the velocity of the water in it, there is a certain part of this reſiſtance which may not be balanced by the tendency which the water has to ſlide along it, provided the pipe be long enough; or if the pipe is too ſhort, the tendency down the pipe may more than balance all the reſiſtances that obtain below. In the firſt caſe, this overplus muſt be balanced by an additional head of water; and in the latter caſe the pipe is not in train, and the water will accelerate. There is ſomething in the mechaniſm of theſe motions which makes a certain length of pipe neceſſary for bringing it into train; a certain portion of the ſurface which acts in concert in obſtructing the motion. We do not completely underſtand this circumſtance, but we can form a pretty diſtinct notion of its mode of acting. The film of water contiguous to the pipe is withheld by the obſtruction, but glides along; the film immediately within this is withheld by the outer film, but glides through it: and thus all the concentric films glide within thoſe around them, ſomewhat like the ſliding tubes of a ſpy-glaſs, when we draw it out by taking hold of the end of the innermoſt. Thus the ſecond film paſſes beyond the firſt or outermoſt, and becomes the outermoſt, and rubs along the tube. The third does the ſame in its turn; and thus the central filaments come at laſt to the outſide, and all ſuſtain their greateſt poſſible obſtruction. When this is accompliſhed, the pipe is in train. This requires a certain length, which we cannot determine by theory. We ſee, however, that pipes of greater diameter muſt require a greater length, and this in a proportion which is probably that of the number of filaments, or the ſquare of the diameter. Buat found this ſuppoſition agree well enough with his experiments. A pipe of one inch in diameter ſuſtained no change of velocity by gradually ſhortening it till he reduced it to ſix feet, and then it diſcharged a little more water. A pipe of two inches diameter gave a ſenſible augmentation of velocity when ſhortened to 25 feet. He therefore ſays, that the ſquare of the diameter in inches, multiplied by 72, will expreſs (in inches) the length neceſſary for putting any pipe in train.

The reſiſtance exerted by a ſquare inch of the pipe makes but a ſmall part of the preſſure which the whole reſiſtances

reſiſtances occaſion to be exerted there before they can be overcome. The reſiſtance may be repreſented by $\frac{d}{s}$, when d is the hydraulic depth (one-fourth of the diameter), and s the length of a column whoſe vertical height is one inch, and it is the relative weight of a column of water whoſe baſe is a ſquare inch, and height is d. For the reſiſtance of any length s of pipe which is in train, is equal to the tendency of the water to ſlide down (being balanced by it); that is, is equal to the weight of this column multiplied by $\frac{1}{s}$. The magnitude of this column is had by multiplying its length by its ſection. The ſection is the product of the border b or circumference, multiplied by the mean depth d, or it is bd. This multiplied by the length, is bds; and this multiplied by the ſlope $\frac{1}{s}$ is bd, the relative weight of the column whoſe length is s. The relative weight of one inch is therefore $\frac{bd}{s}$; and this is in equilibrio with the reſiſtance of a ring of the pipe one inch broad. This, when unfolded, is a parallelogram b inches in length. One inch of this therefore is $\frac{d}{s}$, the relative weight of a column of water having d for its height and a ſquare inch for its baſe. Suppoſe the pipe four inches in diameter, and the ſlope $= 253$, the reſiſtance is one grain; for an inch of water weighs 253 grains.

This knowledge of the preſſure of water in motion is of great importance. In the management of rivers and canals it inſtructs us concerning the damages which they produce in their beds by tearing up the ſoil; it informs us of the ſtrength which we muſt give to the banks: but it is of more conſequence in the management of cloſe conduits. By this we muſt regulate the ſtrength of our pipes; by this alſo we muſt aſcertain the quantities of water which may be drawn off by lateral branches from any main conduit.

With reſpect to the firſt of theſe objects, where ſecurity is our ſole concern, it is proper to conſider the preſſure in the moſt unfavourable circumſtances, viz. when the end of the main is ſhut. This caſe is not unfrequent. Nay, when the water is in motion, its velocity in a conduit ſeldom exceeds a very few feet in a ſecond. Eight feet per ſecond requires only one foot of water to produce it. We ſhould therefore eſtimate the ſtrain on all conduits by the whole height of the reſervoir.

In order to adjuſt the ſtrength of a pipe to the ſtrain, we may conceive it as conſiſting of two half cylinders of inſuperable ſtrength, joined along the two ſeams, where the ſtrength is the ſame with the ordinary ſtrength of the materials of which it is made. The inſide preſſure tends to burſt the pipe by tearing open theſe ſeams; and each of theſe two ſeams is equal to the weight of a column of water whoſe height is the depth of the ſeam below the ſurface of the reſervoir, and whoſe baſe is an inch broad and a diameter of the pipe in length. This follows from the common principles of hydroſtatics.

Suppoſe the pipe to be of lead, one foot in diameter and 100 feet under the ſurface of the reſervoir. Water weighs $62\frac{1}{2}$ pounds per foot. The baſe of our column is therefore $\frac{1}{12}$th of a foot, and the tendency to burſt the pipe is $100 \times 62\frac{1}{2} \times \frac{1}{12}\text{th} = \frac{6250}{12}, = 521$ pounds nearly. Therefore an inch of one ſeam is ſtrained by $260\frac{1}{2}$ pounds. A rod of lead one inch ſquare is pulled aſunder by 860 pounds (ſee *STRENGTH of Materials*, N° 40.). Therefore, if the thickneſs of the ſeam is $= \frac{260}{860}$ inches, or one-third of an inch, it will juſt withſtand this ſtrain. But we muſt make it much ſtronger than this, eſpecially if the pipe leads from an engine which ſends the water along it by ſtarts. Belidor and Deſaguliers have given tables of the thickneſs and weights of pipes which experience has found ſufficient for the different materials and depths. Deſaguliers ſays, that a leaden pipe of three-fourths of an inch in thickneſs is ſtrong enough for a height of 140 feet and diameter of ſeven inches. From this we may calculate all others. Belidor ſays, that a leaden pipe 12 inches diameter and 60 feet deep ſhould be half an inch thick: but theſe things will be more properly computed by means of the liſt given in N° 40 of the article *STRENGTH of Materials*.

The application which we are moſt anxious to make of the knowledge of the preſſure of moving waters is the derivation from a main conduit by lateral branches. This occurs very frequently in the diſtribution of waters among the inhabitants of towns; and it is ſo imperfectly underſtood by the greateſt part of thoſe who take the name of engineers, that individuals have no ſecurity that they ſhall get even one half of the water they bargain and pay for; yet this may be as accurately aſcertained as any other problem in hydraulics by means of our general theorem. The caſe therefore merits our particular attention.

It appears to be determined already, when we have aſcertained the preſſures by which the water is impelled into theſe lateral pipes, eſpecially after we have ſaid that the experiments of Boſſut on the actual diſcharges from a lateral pipe fully confirm the theoretical doctrine. But much remains to be conſidered. We have ſeen that there is a vaſt difference between the diſcharge made through a hole, or even through a ſhort pipe, and the diſcharge from the far end of a pipe derived from a main conduit. And even when this has been aſcertained by our new theory, the diſcharge thus modified will be found conſiderably different from the real ſtate of things: For when water is flowing along a main with a known velocity, and therefore exerting a known preſſure on the circle which we propoſe for the entry of a branch, if we inſert a branch there water will go along it: but this will generally make a conſiderable change in the motion along the main, and therefore in the preſſure which is to expel the water. It alſo makes a conſiderable change in the whole quantity which paſſes along the anterior part of the main, and a ſtill greater change on what moves along that part of it which lies beyond the branch: it therefore affects the quantity neceſſary for the whole ſupply, the force that is required for propelling it, and the quantity delivered by other branches. This part therefore of the management of water in conduits is of conſiderable importance and intricacy. We can propoſe in this place nothing more than a ſolution of ſuch leading queſtions as involve the chief circumſtances, recommending to our readers the peruſal of original works on this ſubject. M. Boſſut's experiments

Water-works.

experiments are fully competent to the eſtabliſhment of the fundament principle. The hole through which the lateral diſcharges were made was but a few feet from the reſervoir. The pipe was ſucceſſively lengthened, by which the reſiſtances were increaſed, and the velocity diminiſhed. But this did not affect the lateral diſcharges, except by affecting the preſſures; and the diſcharges from the end of the main were ſuppoſed to be the ſame as when the lateral pipe was not inſerted. Although this was not ſtrictly true, the difference was inſenſible, becauſe the lateral pipe had but about the 18th part of the area of the main.

Suppoſe that the diſcharge from the reſervoir remains the ſame after the derivation of this branch, then the motion of the water all the way to the inſertion of the branch is the ſame as before; but, beyond this, the diſcharge is diminiſhed by all that is diſcharged by the branch, with the head x equivalent to the preſſure on the ſide. The diſcharge by the lower end of the main being diminiſhed, the velocity and reſiſtance in it are alſo diminiſhed. Therefore the difference between x and the head employed to overcome the friction in this ſecond caſe, would be a needleſs or inefficient part of the whole load at the entry, which is impoſſible; for every force produces an effect, or it is deſtroyed by ſome reaction. The effect of the forcing head of water is to produce the greateſt diſcharge correſponding to the obſtructions; and thus the diſcharge from the reſervoir, or the ſupply to the main, muſt be augmented by the inſertion of the branch, if the forcing head of water remains the ſame. A greater portion therefore of the forcing head was employed in producing a greater diſcharge at the entry of the main, and the remainder, leſs than x, produced the preſſure on the ſides. This head was the one competent to the obſtructions reſulting from the velocity beyond the inſertion of the branch; and this velocity, diminiſhed by the diſcharge already made, was leſs than that at the entry, and even than that of the main without a branch. This will appear more diſtinctly by putting the caſe into the form of an equation. Therefore let $H-x$ be the height due to the velocity at the entry, of which the effect obtains only horizontally. The head x is the only one which acts on the ſides of the tube, tending to produce the diſcharge by the branch, at the ſame time that it muſt overcome the obſtructions beyond the branch. If the orifice did not exiſt, and if the force producing the velocity on a ſhort tube be repreſented by $2G$, and the ſection of the main be A, the ſupply at the entry of the main would be $A\sqrt{2G}\sqrt{H-x}$; and if the orifice had no influence on the value of x, the diſcharge by the orifice would be $D\sqrt{\frac{x}{H}}$, D being its diſcharge by means of the head H, when the end of the main is ſhut; for the diſcharges are in the ſubduplicate ratio of the heads of water by which they are expelled; and therefore $\sqrt{H} : \sqrt{x} = D : D\sqrt{\frac{x}{H}} (= \partial)$. But we have ſeen that x muſt diminiſh; and we know that the obſtructions are nearly as the ſquare roots of the velocities, when theſe do not differ much among themſelves. Therefore calling y the preſſure or head which balances the reſiſtances of the main without a branch, while x is the head neceſſary for the main with a branch, w may inſtitute this proportion, $y : H-y = x \frac{x(H-y)}{y}$; and this 4th term will expreſs the head producing the velocity in the main beyond the branch (as $H-y$ would have done in a main without a branch). This velocity beyond the branch will be $\sqrt{2G}\sqrt{\frac{x(H-y)}{y}}$, and the diſcharge at the end will be $A\sqrt{2G}\sqrt{\frac{x(H-y)}{y}}$. If to this we add the diſcharge of the branch, the ſum will be the whole diſcharge, and therefore the whole ſupply. Therefore we have the following equation, $A\sqrt{2G}\sqrt{H-y} = A\sqrt{2G}\sqrt{\frac{x(H-y)}{y}} + D\sqrt{\frac{x}{H}}$. From this we deduce the value of x

$$= \frac{2GHA^2}{\left(A\sqrt{2G}\sqrt{\frac{H-y}{y}} + \frac{D}{\sqrt{H}}\right)^2 + 2GA^2}.$$

This value of x being ſubſtituted in the equation of the diſcharge ∂ of the branch, which was $= D\sqrt{\frac{x}{H}}$, will give the diſcharges required, and they will differ ſo much the more from the diſcharges calculated according to the ſimple theory, as the velocity in the main is greater. By the ſimple theory, we mean the ſuppoſition that the lateral diſcharges are ſuch as would be produced by the head $H-h$, where H is the height of the reſervoir, and h the head due to the actual velocity in the main.

And thus it appears that the proportion of the diſcharge by a lateral pipe from a main that is ſhut at the far end, and the diſcharge from a main that is open, depends not only on the preſſures, but alſo on the ſize of the lateral pipe, and its diſtance from the reſervoir. When it is large, it greatly alters the train of the main, under the ſame head, by altering the diſcharge at its extremity, and the velocity in it beyond the branch; and if it be near the reſervoir, it greatly alters the train, becauſe the diminiſhed velocity takes place through a greater extent, and there is a greater diminution of the reſiſtances.

When the branch is taken off at a conſiderable diſtance from the reſervoir, the problem becomes more complicated, and the head x is reſolved into two parts; one of which balances the reſiſtance in the firſt part of the main, and the other balances the reſiſtances beyond the lateral pipe, with a velocity diminiſhed by the diſcharge from the branch.—A branch at the end of the main produces very little change in the train of the pipe.

When the lateral diſcharge is great, the train may be ſo altered, that the remaining part of the main will not run full, and then the branch will not yield the ſame quantity. The velocity in a very long horizontal tube may be ſo ſmall (by a ſmall head of water and great obſtructions in a very long tube) that it will juſt run full. An orifice made in its upper ſide will yield nothing; and yet a ſmall tube inſerted into it will carry a column almoſt as high as the reſervoir. So that we cannot judge in all caſes of the preſſures by the diſcharges, and *vice verſa*.

If there be an inclined tube, having a head greater than what is competent to the velocity, we may bring it into train by an opening on its upper ſide near the reſervoir. This will yield ſome water, and the velocity will diminiſh in the tube till it is in train. If we ſhould now enlarge the hole, it will yield no more water than before.

And thus we have pointed out the chief circumſtances which affect theſe lateral diſcharges. The diſcharges are afterwards modified by the conduits in which they are conveyed to their places of deſtination. Theſe being generally of ſmall dimenſions, for the ſake of economy, the velocity is much diminiſhed. But, at the ſame time, it approaches nearer to that which the ſame conduit would bring directly from the reſervoir, becauſe its ſmall velocity will produce a leſs change in the train of the main conduit.

We ſhould now treat of jets of water, which ſtill make an ornament in the magnificent pleaſure grounds of the wealthy. Some of theſe are indeed grand objects, ſuch as the two at Peterhoff in Ruſſia, which ſpout about 60 feet high a column of nine inches diameter, which falls again, and ſhakes the ground with its blow. Even a ſpout of an inch or two inches diameter, lancing to the height of 150 feet, is a gay object, and greatly enlivens a pleaſure-ground; eſpecially when the changes of a gentle breeze bend the jet to one ſide. But we have no room left for treating this ſubject, which is of ſome nicety; and muſt conclude this article with a very ſhort account of the management of water as an active power for impelling machinery.

II. *Of Machinery driven by Water.*

This is a very comprehenſive article, including almoſt every poſſible ſpecies of mill. It is no leſs important, and it is therefore matter of regret, that we cannot enter into the detail which it deſerves. The mere deſcription of the immenſe variety of mills which are in general uſe, would fill volumes, and a ſcientific deſcription of their principles and maxims of conſtruction would almoſt form a complete body of mechanical ſcience. But this is far beyond the limits of a work like ours. Many of theſe machines have been already deſcribed under their proper names, or under the articles which give an account of their manufactures; and for others we muſt refer our readers to the original works, where they are deſcribed in minute detail. The great academical collection *Des Arts et Metiers*, publiſhed at Paris in many folio volumes, contains a deſcription of the peculiar machinery of many mills; and the volumes of the *Encyclopédie Methodique*, which particularly relate to the mechanic arts, already contain many more. All that we can do in this place is, to conſider the chief circumſtances that are common to all water-mills, and from which all muſt derive their efficacy. Theſe circumſtances are to be found in the manner of employing water as an acting power, and moſt of them are comprehended in the conſtruction of water-wheels. When we have explained the principles and the maxims of conſtruction of a water-wheel, every reader converſant in mechanics knows, that the axis of this wheel may be employed to tranſmit the force impreſſed on it to any ſpecies of machinery. Therefore nothing ſubſequent to this can with propriety be conſidered as *water-works*.

Water-wheels are of two kinds, diſtinguiſhed by the manner in which water is made an impelling power, viz. by its weight, or by its impulſe. This requires a very different form and manner of adaptation; and this forms an oſtenſible diſtinction, ſufficiently obvious to give a name to each claſs. When water is made to act by its weight, it is delivered from the ſpout as high on the wheel as poſſible, that it may continue long to preſs it down: but when it is made to ſtrike the wheel, it is delivered as low as poſſible, that it may have previouſly acquired a great velocity. And thus the wheels are ſaid to be OVERSHOT or UNDERSHOT.

Of Overſhot Wheels.

This is nothing but a frame of open buckets, ſo diſpoſed round the rim of a wheel as to receive the water delivered from a ſpout; ſo that one ſide of the wheel is loaded with water, while the other is empty. The conſequence muſt be, that the loaded ſide muſt deſcend. By this motion the water runs out of the lower buckets, while the empty buckets of the riſing ſide of the wheel come under the ſpout in their turn, and are filled with water.

If it were poſſible to conſtruct the buckets in ſuch a manner as to remain completely filled with water till they come to the very bottom of the wheel, the preſſure with which the water urges the wheel round its axis would be the ſame as if the extremity of the horizontal radius were continually loaded with a quantity of water ſufficient to fill a ſquare pipe, whoſe ſection is equal to that of the bucket, and whoſe length is the diameter of the wheel. For let the buckets BD and EF (fig. 5.) be compared together, the arches DB and EF are equal. The mechanical energy of the water contained in the bucket EF, or the preſſure with which its weight urges the wheel, is the ſame as if all this water were hung on that point T of the horizontal arm CF, where it is cut by the vertical or plumb-line BT. This is plain from the moſt elementary principles of mechanics. Therefore the effect of the bucket BD is to that of the bucket EF as CT to CF or CB. Draw the horizontal lines PB$b\,b$, QD$d\,d$. It is plain, that if BD is taken very ſmall, ſo that it may be conſidered as a ſtraight line, $BD : BO = CB : BP$, and $EF : b\,d = CF : CT$, and $EF \times CT = b\,d \times CF$. Therefore if the priſm of water, whoſe vertical ſection is $b\,b\,d\,d$, were hung on at F, its force to urge the wheel round would be the ſame as that of the water lying in the bucket BD. The ſame may be ſaid of every bucket; and the effective preſſure of the whole ring of water $A\,f\,HKFI$, in its natural ſituation, is the ſame with the pillar of water $a\,h\,h\,a$ hung on at F. And the effect of any portion BF of this ring is the ſame with that of the correſponding portion $b\,F\,f\,b$ of the vertical pillar. We do not take into account the ſmall difference which ariſes from the depth B or $F\,f$, becauſe we may ſuppoſe the circle deſcribed through the centres of gravity of the buckets. And in the farther proſecution of this ſubject, we ſhall take ſimilar liberties, with the view of ſimplifying the ſubject, and ſaving time to the reader.

Fig. 5.

But ſuch a ſtate of the wheel is impoſſible. The bucket at the very top of the wheel may be completely filled with water; but when it comes into the oblique poſition BD, a part of the water muſt run over the outer edge ∂, and the bucket will only retain the quantity

tity ZBD∂; and if the buckets are formed by partitions directed to the axis of the wheel, the whole water muſt be run out by the time that they deſcend to the level of the axis. To prevent this many contrivances have been adopted. The wheel has been ſurrounded with a hoop or ſweep, conſiſting of a circular board, which comes almoſt into contact with the rim of the wheel, and terminates at H, where the water is allowed to run off. But unleſs the work is executed with uncommon accuracy, the wheel made exactly round, and the ſweep exactly fitting it, a great quantity of water eſcapes between them; and there is a very ſenſible obſtruction to the motion of ſuch a wheel, from ſomething like friction between the water and the ſweep. Froſt alſo effectually ſtops the motion of ſuch a wheel. Sweeps have therefore been generally laid aſide, although there are ſituations where they might be uſed with good effect.

Mill-wrights have turned their whole attention to the giving a form to the buckets which ſhall enable them to retain the water along a great portion of the circumference of the wheel. It would be endleſs to deſcribe all theſe contrivances; and we ſhall therefore content ourſelves with one or two of the moſt approved. The intelligent reader will readily ſee that many of the circumſtances which concur in producing the ultimate effect (ſuch as the facility with which the water is received into the buckets, the place which it is to occupy during the progreſs of the bucket from the top to the bottom of the wheel, the readineſs with which they are evacuated, or the chance that the water has of being dragged beyond the bottom of the wheel by its adheſion, &c. &c.) are ſuch as do not admit of preciſe calculation or reaſoning about their merits; and that this or that form can ſeldom be evidently demonſtrated to be the very beſt poſſible. But, at the ſame time, he will ſee the general reaſons of preference, and his attention will be directed to circumſtances which muſt be attended to, in order to have a good bucketed wheel.

Fig. 6. Fig. 6. is the outline of a wheel having 40 buckets. The ring of board contained between the concentric circles QDS and PAR, making the ends of the buckets, is called the SHROUDING, in the language of the art, and QP is called the *depth of ſhrouding*. The inner circle PAR is called the SOLE of the wheel, and uſually conſiſts of boards nailed to ſtrong wooden rings of compaſs timber of conſiderable ſcantling, firmly united with the ARMS or radii. The partitions, which determine the form of the buckets, conſiſt of three different planes or boards AB, BC, CD, which are variouſly named by different artiſts. We have heard them named the START or SHOULDER, the ARM, and the WREST (probably for wriſt, on account of a reſemblance of the whole line to the human arm); B is alſo called the ELBOW. Fig. 7. represents a ſmall portion of the ſame bucketing on a larger ſcale, that the proportions of the parts may be more diſtinctly ſeen. AG, the ſole of one bucket, is made about $\frac{1}{5}$th more than the depth GH of the ſhrouding. The ſtart AB is $\frac{1}{2}$ of AI. The plane BC is ſo inclined to AB that it would paſs through H; but it is made to terminate in C, in ſuch a manner that FC is $\frac{5}{6}$ths of GH or AI. Then CD is ſo placed that HD is about $\frac{1}{5}$th of IH.

Fig. 7.

By this conſtruction, it follows that the area FABC is very nearly equal to DABC; ſo that the water which will fill the ſpace FABC will all be contained in the bucket when it ſhall come into ſuch a poſition that AD is a horizontal line; and the line AB will then make an angle of nearly 35° with the vertical, or the bucket will be 35° from the perpendicular. If the bucket deſcend ſo much lower that one half of the water runs out, the line AB will make an angle of 25°, or 24° nearly, with the vertical. Therefore the wheel, filled to the degree now mentioned, will *begin* to loſe water at about $\frac{1}{8}$th of the diameter from the bottom, and *half of the water will be diſcharged* from the loweſt bucket, about $\frac{1}{24}$th of the diameter farther down. Theſe ſituations of the diſcharging bucket are marked at T and V in fig. 6. Had a greater proportion of the buckets been filled with water when they were under the ſpout, the diſcharge would have begun at a greater height from the bottom, and we ſhould loſe a greater portion of the whole fall of water. The loſs by the preſent conſtruction is leſs than $\frac{1}{10}$th (ſuppoſing the water to be delivered into the wheel at the very top), and may be eſtimated at about $\frac{1}{12}$th; for the loſs is the verſed ſine of the angle which the radius of the bucket makes with the vertical. The verſed ſine of 35° is nearly $\frac{1}{5}$th of the radius (being 0.18085), or $\frac{1}{10}$th of the diameter. It is evident, that if only $\frac{1}{2}$ of this water were ſupplied to each bucket as it paſſes the ſpout, it would have been retained for 10° more of a revolution, and the loſs of fall would have been only about $\frac{1}{18}$th.

Theſe obſervations ſerve to ſhow, in general, that an advantage is gained by having the buckets ſo capacious that the quantity of water which each can receive as it paſſes the ſpout may not nearly fill it. This may be accompliſhed by making them of a ſufficient length, that is, by making the wheel ſufficiently broad between the two ſhroudings. Economy is the only objection to this practice, and it is generally very ill placed. When the work to be performed by the wheel is great, the addition of power gained by a greater breadth will ſoon compenſate for the additional expence.

The third plane CD is not very frequent; and mill-wrights generally content themſelves with continuing the board all the way from the elbow B to the outer edge of the wheel at H; and AB is generally no more than one-third of the depth AI. But CD is a very evident improvement, cauſing the wheel to retain a very ſenſible addition to the water. Some indeed make this addition more conſiderable, by bringing BC more outward, ſo as to meet the rim of the wheel at H, for inſtance, and making HD coincide with the rim. But this makes the entry of the water ſomewhat more difficult during the very ſhort time that the opening of the bucket paſſes the ſpout. To facilitate this as much as poſſible, the water ſhould get a direction from the ſpout, ſuch as will ſend it into the buckets in the moſt perfect manner. This may be obtained by delivering the water through an aperture that is divided by thin plates of board or metal, placed in the proper poſition, as we have repreſented in fig. 6. The form of bucket laſt mentioned, having the wreſt concentric with the rim, is unfavourable to the ready admiſſion of the water; whereas an oblique wreſt conducts the water which has miſſed one bucket into the next below.

The mechanical conſideration of this ſubject alſo ſhows us, that a deep ſhrouding, in order to make a capacious bucket,

bucket, is not a good method: it does not make the buckets retain their water any longer; and it diminiſhes the effective fall of water: for the water received at the top of the wheel immediately falls to the bottom of the bucket, and thus ſhortens the fictitious pillar of water, which we ſhowed to be the meaſure of the effective or uſeful preſſure on the wheel: and this concurs with our former reaſons for recommending as great a breadth of the wheel, and length of buckets, as economical conſiderations will permit.

A bucket wheel was ſome time ago executed by Mr Robert Burns, at the cotton mills of Houſton, Burns, and Co. at Cartſide in Renfrewſhire, of a conſtruction entirely new, but founded on a good principle, which is ſuſceptible of great extenſion. It is repreſented in fig. 8. *Fig. 8.* The bucket conſiſts of a ſtart AB, an arm BC, and a wreſt CD, concentric with the rim. But the bucket is alſo divided by a partition LM, concentric with the ſole and rim, and ſo placed as to make the inner and outer portions of nearly equal capacity. It is evident, without any farther reaſoning about it, that this partition will enable the bucket to retain its water much longer. When they are filled one-third, they retain the whole water at 18° from the bottom; and they retain one half at 11°. They do not admit the water quite ſo freely as buckets of the common conſtruction; but by means of the contrivance mentioned a little ago for the ſpout (alſo the invention of Mr Burns, and furniſhed with a rack-work, which raiſed or depreſſed it as the ſupply of water varied, ſo as at all times to employ the whole fall of the water), it is found, that a ſlow-moving wheel allows one-half of the water to get into the inner buckets, eſpecially if the partition do not altogether reach the radius drawn through the lip D of the outer bucket.

This is a very great improvement of the bucket wheel; and when the wheel is made of a liberal breadth, ſo that the water may be very ſhallow in the buckets, it ſeems to carry the performance as far as it can go. Mr Burns made the firſt trial on a wheel of 24 feet diameter; and its performance is manifeſtly ſuperior to that of the wheel which it replaced, and which was a very good one. It has alſo another valuable property: When the ſupply of water is very ſcanty, a proper adjuſtment of the apparatus in the ſpout will direct almoſt the whole of the water into the outer buckets; which, by placing it at a greater diſtance from the axis, makes a very ſenſible addition to its mechanical energy.

We ſaid that this principle is ſuſceptible of conſiderable extenſion; and it is evident that two partitions will increaſe the effect, and that it will increaſe with the number of partitions: ſo that when the practice now begun, of making water-wheels of iron, ſhall become general, and therefore very thin partitions are uſed, their number may be greatly increaſed without any inconvenience: and it is obvious, that this ſeries of partitions muſt greatly contribute to the ſtiffneſs and general firmneſs of the whole wheel.

There frequently occurs a difficulty in the making of bucket wheels, when the half-taught mill-wright attempts to retain the water a long time in the buckets. The water gets into them with a difficulty which he cannot account for, and ſpills all about, even when the buckets are not moving away from the ſpout. This ariſes from the air, which muſt find its way out to admit the water, but is obſtructed by the entering water, and occaſions a great ſputtering at the entry. This may be entirely prevented by making the ſpout conſiderably narrower than the wheel. This will leave room at the two ends of the buckets for the eſcape of the air. This obſtruction is vaſtly greater than one would imagine; for the water drags along with it a great quantity of air, as is evident in the *Water-blaſt* deſcribed by many authors.

There is another and very ſerious obſtruction to the motion of an overſhot or bucketed wheel. When it moves in back water, it is not only reſiſted by the water, when it moves more ſlowly than the wheel, which is very frequently the caſe, but it lifts a great deal in the riſing buckets. In ſome particular ſtates of back water, the deſcending bucket fills itſelf completely with water; and, in other caſes, it contains a very conſiderable quantity, and air of common denſity; while in ſome rarer caſes it contains leſs water, with air in a condenſed ſtate. In the firſt caſe, the riſing bucket muſt come up filled with water, which it cannot drop till its mouth get out of the water. In the ſecond caſe, part of the water goes out before this; but the air rarefies, and therefore there is ſtill ſome water dragged or lifted up by the wheel, by ſuction as it is uſually called. In the laſt caſe there is no ſuch back load on the riſing ſide of the wheel, but (which is as detrimental to its performance) the deſcending ſide is employed in condenſing air; and although this air aids the aſcent of the riſing ſide, it does not aid it ſo much as it impedes the deſcending ſide, being (by the form of the bucket) nearer to the vertical line drawn through the axis.

All this may be completely prevented by a few holes made in the ſturt of each bucket. Air being at leaſt 800 times rarer than water, will eſcape through a hole almoſt 30 times faſter with the ſame preſſure. Very moderate holes will therefore ſuffice for this purpoſe: and the ſmall quantity of water which theſe holes diſcharge during the deſcent of the buckets, produces a loſs which is altogether inſignificant. The water which runs out of one runs into another, ſo that there is only the loſs of one bucket. We have ſeen a wheel of only 14 feet diameter working in nearly three feet of back water. It laboured prodigiouſly, and brought up a great load of water, which fell from it in abrupt daſhes, which rendered the motion very hobbling. When three holes of an inch diameter were made in each bucket (12 feet long), the wheel laboured no more, there was no more plunging of water from its riſing ſide, and its power on the machinery was increaſed more than one-fourth.

Theſe practical obſervations may contain information that is new even to ſeveral experienced mill-wrights. To perſons leſs informed they cannot fail of being uſeful. We now proceed to conſider the action of water thus lying in the buckets of a wheel; and to aſcertain its energy as it may be modified by different circumſtances of fall, velocity, &c.

With reſpect to variations in the fall, there can be little room for diſcuſſion. Since the active preſſure is meaſured by the pillar of water reaching from the horizontal plane where it is delivered on the wheel, to the horizontal plane where it is ſpilled by the wheel, it is evident that it muſt be proportional to this pillar, and therefore we muſt deliver it as high and retain it as long as poſſible.

This maxim obliges us, in the firſt place, to uſe a wheel

wheel whoſe diameter is equal to the whole fall. We ſhall not gain any thing by employing a larger wheel; for although we ſhould gain by uſing only that part of the circumference where the weight will act more perpendicularly to the radius, we ſhall loſe more by the neceſſity of diſcharging the water at a greater height from the bottom: For we muſt ſuppoſe the buckets of both the wheels equally well conſtructed; in which caſe, the heights above the bottom, where they will diſcharge the water, will increaſe in the proportion of the diameter of the wheel. Now, that we ſhall loſe more by this than we gain by a more direct application of the weight, is plain, without any further reaſoning, by taking the extreme caſe, and ſuppoſing our wheel enlarged to ſuch a ſize, that the uſeleſs part below is equal to our whole fall. In this caſe the water will be ſpilled from the buckets as ſoon as it is delivered into them. All intermediate caſes, therefore, partake of the imperfection of this.

Fig. 9.

When our fall is exceedingly great, a wheel of an equal diameter becomes enormouſly big and expenſive, and is of itſelf an unmanageable load. We have ſeen wheels of 58 feet diameter, however, which worked extremely well; but they are of very difficult conſtruction, and extremely apt to warp and go out of ſhape by their weight. In caſes like this, where we are unwilling to loſe any part of the force of a ſmall ſtream, the beſt form of a bucket wheel is an inverted chain pump. Inſtead of employing a chain pump of the beſt conſtruction, ABCDEA (fig. 9.) to raiſe water through the upright pipe CB, by means of a force applied to the upper wheel A, let the water be delivered from a ſpout F, into the upper part of the pipe BC, and it will preſs down the plugs in the lower and narrower bored part of it with the full weight of the column, and eſcape at the dead level of C. This weight will urge round the wheel A without any defalcation: and this is the moſt powerful manner that any fall of water whatever can be applied, and exceeds the moſt perfect overſhot wheel. But though it excels all chains of buckets in economy and in effect, it has all the other imperfections of this kind of machinery. Though the chain of plugs be of great ſtrength, it has ſo much motion in its joints that it needs frequent repairs; and when it breaks, it is generally in the neighbourhood of A, on the loaded ſide, and all comes down with great a craſh. There is alſo a loſs of power by the immerſion of ſo many plugs and chains in the water; for there can be no doubt but that if the plugs were big enough and light enough, they would buoy and even draw up the plugs in the narrow part at C. They muſt therefore diminiſh, in all other caſes, the force with which this plug is preſſed down.

The velocity of an overſhot wheel is a matter of very great nicety; and authors, both ſpeculative and practical, have entertained different, nay oppoſite, opinions on the ſubject. Mr Belidor, whom the engineers of Europe have long been accuſtomed to regard as ſacred authority, maintains, that there is a certain velocity related to that obtainable by the whole fall, which will procure to an overſhot wheel the greateſt performance. Deſaguliers, Smeaton, Lambert, De Parcieux, and others, maintain, that there is no ſuch relation, and that the performance of an overſhot wheel will be the greater, as it moves more ſlowly by an increaſe of its load of work. Belidor maintains, that the active power of water lying in a bucket wheel of any diameter is equal to that of the impulſe of the ſame water on the floats of an underſhot wheel, when the water iſſues from a ſluice in the bottom of the dam. The other writers whom we have named aſſert, that the energy of an underſhot wheel is but one half of that of an overſhot, actuated by the ſame quantity of water falling from the ſame height.

To a manufacturing country like ours, which derives aſtoniſhing ſuperiority, by which it more than compenſates for the impediments of heavy taxes and luxurious living, chiefly from its machinery, in which it leaves all Europe far behind, the deciſion of this queſtion, in ſuch a manner as ſhall leave no doubt or miſconception in the mind even of an unlettered artiſt, muſt be conſidered as a material ſervice: and we think that this is eaſily attainable.

When any machine moves uniformly, the accelerating force or preſſure actually exerted on the impelled point of the machine is in equilibrio with all the reſiſtances which are exerted at the working point, with thoſe ariſing from friction, and thoſe that are excited in different parts of the machine by their mutual actions. This is an inconteſtable truth; and though little attended to by the mechanicians, is the foundation of all practical knowledge of machines. Therefore, when an overſhot wheel moves uniformly, with *any velocity whatever*, the water is acting with its whole weight: for gravity would accelerate its deſcent, if not completely balanced by ſome reaction; and in this balance gravity and the reacting part of the machine exert equal and oppoſite preſſures, and thus produce the uniform motion of the machine. We are thus particular on this point, becauſe we obſerve mechanicians of the firſt name employing a mode of reaſoning on the queſtion now before us which is ſpecious, and appears to prove the concluſion which they draw; but is nevertheleſs contrary to true mechanical principles. They aſſert, that the ſlower a heavy body is deſcending (ſuppoſe in a ſcale ſuſpended from an axis *in peritrochea*), the more does it preſs on the ſcale, and the more does it urge the machine round: and therefore the ſlower an overſhot wheel turns, the greater is the force with which the water urges it round, and the more work will be done. It is very true that the machine is more forcibly impelled, and that more work is done: but this is not becauſe a pound of water preſſes more ſtrongly, but becauſe there is more water preſſing on the wheel; for the ſpout ſupplies at the ſame rate, and each bucket receives more water as it paſſes by it.

Let us therefore examine this point by the unqueſtionable principles of mechanics.

Fig. 5.

Let the overſhot wheel A*f*H (fig. 5.) receive the water from a ſpout at the very top of the wheel; and, in order that the wheel may not be retarded by dragging into motion the water ſimply laid into the uppermoſt bucket at A, let it be received at B, with the velocity (directed in a tangent to the wheel) acquired by the head of water AP. This velocity, therefore, muſt be equal to that of the rim of the wheel. Let this be v, or let the wheel and the water move over v inches in a ſecond. Let the buckets be of ſuch dimenſions, that all the water which each receives as it paſſes the ſpout is retained till it comes to the poſition R, where it is diſcharged at once. It is plain that, in place of the ſeparate quantities of water lying in each bucket, we may ſubſtitute a continued ring of water, equal to their

ſum,

Water-works.

ſum, and uniformly diſtributed in the ſpace BER $\varrho f\beta$. This conſtitutes a ring of uniform thickneſs. Let the area of its croſs ſection βB or Ff be called a. We have already demonſtrated, that the mechanical energy with which this water on the circumference of the wheel urges it round, is the ſame with what would be exerted by the pillar $b r r b$ preſſing on Ff, or acting by the lever CF. The weight of this pillar may be expreſſed by $a\times b r$, or $a\times\mathrm{PS}$; and if we call the radius CF of the wheel R, the momentum or mechanical energy of this weight will be repreſented by $a\times\mathrm{PS}\times\mathrm{R}$.

Now, let us ſuppoſe that this wheel is employed to raiſe a weight W, which is ſuſpended by a rope wound round the axis of the wheel. Let r be the radius of this axle. Then $\mathrm{W}\times r$ is the momentum of the work. Let the weight riſe with the velocity u when the rim of the wheel turns with the velocity v, that is, let it riſe u inches in a ſecond.

Since a perfect equilibrium obtains between the power and the work when the motion is uniform, we muſt have $\mathrm{W}\times r=a\times\mathrm{PS}\times\mathrm{R}$. But it is evident that $\mathrm{R}:r=v:u$. Therefore $\mathrm{W}\times u=a\times v\times\mathrm{PS}$.

Now the performance of the machine is undoubtedly meaſured by the weight and the height to which it is raiſed in a ſecond, or by $\mathrm{W}\times u$. Therefore the machine is in its beſt poſſible ſtate when $a\times v\times\mathrm{PS}$ is a maximum. But it is plain that $a\times v$ is an invariable quantity; for it is the cubic inches of water which the ſpout ſupplies in a ſecond. If the wheel moves faſt, little water lies in each bucket, and a is ſmall. When v is ſmall, a is great, for the oppoſite reaſon; but $a\times v$ remains the ſame. Therefore we muſt make PS a maximum, that is, we muſt deliver the water as high up as poſſible. But this diminiſhes AP, and this diminiſhes the velocity of the wheel: and as this has no limit, the propoſition is demonſtrated; and an overſhot wheel does the more work as it moves ſloweſt.

Convincing as this diſcuſſion muſt be to any mechanician, we are anxious to impreſs the ſame maxim on the minds of practical men, unaccuſtomed to mathematical reaſoning of any kind. We therefore beg indulgence for adding a popular view of the queſtion, which requires no ſuch inveſtigation.

We may reaſon in this way: Suppoſe a wheel having 30 buckets, and that ſix cubic feet of water are delivered in a ſecond on the top of a wheel, and diſcharged without any loſs by the way at a certain height from the bottom of the wheel. Let this be the caſe, whatever is the rate of the wheel's motion; the buckets being of a ſufficient capacity to hold all the water which falls into them. Let this wheel be employed to raiſe a weight of any kind, ſuppoſe water in a chain of 30 buckets, to the ſame height, and with the ſame velocity. Suppoſe, farther, that when the load on the riſing ſide of the machine is one half of that on the wheel, the wheel makes four turns in a minute, or one turn in 15 ſeconds. During this time 90 cubic feet of water have flowed into the 30 buckets, and each has received three cubic feet. Then each of the riſing buckets contains $1\frac{1}{2}$ feet; and 45 cubic feet are delivered into the upper ciſtern during one turn of the wheel, and 180 cubic feet in one minute.

Now, ſuppoſe the machine ſo loaded, by making the riſing buckets more capacious, that it makes only two turns in a minute, or one turn in 30 ſeconds. Then each deſcending bucket muſt contain ſix cubic feet of water. If each bucket of the riſing ſide contained three cubic feet, the motion of the machine would be the ſame as before. This is a point which no mechanician will controvert. When two pounds are ſuſpended to one end of a ſtring which paſſes over the pulley, and one pound to the other end, the deſcent of the two pound will be the ſame with that of a four pounds weight, which is employed in the ſame manner to draw up two pounds. Our machine would therefore continue to make four turns in the minute, and would deliver 90 cubic feet during each turn, and 360 in a minute. But, by ſuppoſition, it is making but two turns in a minute: this muſt proceed from a greater load than three cubic feet of water in each riſing bucket. The machine muſt therefore be raiſing *more* than 90 feet of water during one turn of the wheel, and *more* than 180 in the minute.

Thus it appears, that if the machine be turning twice as ſlow as before, there is *more than twice the former quantity* in the riſing buckets, and more will be raiſed in a minute by the ſame expenditure of power. In like manner, if the machine go three times as ſlow, there muſt be *more than three times* the former quantity of water in the riſing buckets, and more work will be done.

But we may go farther, and aſſert, that the *more* we retard the machine, by loading it with more work of a ſimilar kind, the greater will be its performance. This does not immediately appear from the preſent diſcuſſion: But let us call the firſt quantity of water in the riſing bucket A; the water raiſed by four turns in a minute will be $4\times30\times\mathrm{A},=120\,\mathrm{A}$. The quantity in this bucket, when the machine goes twice as ſlow, has been ſhown to be greater than 2 A (call it $2\,\mathrm{A}+x$); the water raiſed by two turns in a minute will be $2\times30\times\overline{2\,\mathrm{A}+x}=120\,\mathrm{A}+60\,x$. Now, let the machine go four times as ſlow, making but one turn in a minute, the riſing bucket muſt now contain more than twice $2\,\mathrm{A}+x$, or more than $4\,\mathrm{A}+2\,x$; call it $4\,\mathrm{A}+2\,x+y$. The work done by one turn in a minute will now be $30\times\overline{4\,\mathrm{A}+2\,x+y}=120\,\mathrm{A}+60\,x+30\,y$.

By ſuch an induction of the work, done with any rates of motion we chooſe, it is evident that the performance of the machine increaſes with every diminution of its velocity that is produced by the mere addition of a ſimilar load of work, or that it does the more work the ſlower it goes.

We have ſuppoſed the machine to be in its ſtate of permanent uniform motion. If we conſider it only in the beginning of its motion, the reſult is ſtill more in favour of ſlow motion: For, at the firſt action of the moving power, the inertia of the machine itſelf conſumes part of it, and it acquires its permanent ſpeed by degrees; during which, the reſiſtances ariſing from the work, friction, &c. increaſe, till they exactly balance the preſſure of the water; and after this the machine accelerates no more. Now the greater the power and the reſiſtance ariſing from the work are, in proportion to the inertia of the machine, the ſooner will all arrive at its ſtate of permanent velocity.

There is another circumſtance which impairs the performance of an overſhot wheel moving with a great velocity, viz. the effects of the centrifugal force on the water in the buckets. Our mill-wrights know well enough, that too great velocity will throw the water out of the buckets; but few, if any, know exactly the diminution of power produced by this cauſe. The following very ſimple conſtruction will determine this: Fig. 10. Let AOB (fig. 10.) be an overſhot wheel, of which AB is the upright diameter, and C is the centre. Make CF the length of a pendulum, which will make two vibrations during one turn of the wheel. Draw FE to the elbow of any of the buckets. The water in this bucket, inſtead of having its ſurface horizontal, as NO, will have it in the direction nO perpendicular to FE very nearly.

For the time of falling along half of FC is to that of two vibrations of this pendulum, or to the time of a revolution of the wheel, as the radius of a circle is to its circumference: and it is well known, that the time of moving along half of AC, by the uniform action of the centrifugal force, is to that of a revolution as the radius of a circle to its circumference. Therefore the time of deſcribing one half of AC by the centrifugal force, is equal to the time of deſcribing one half of FC by gravity. Theſe ſpaces, being ſimilarly deſcribed in equal times, are proportional to the accelerating forces. Therefore $\frac{1}{2}$FC : $\frac{1}{2}$AC, or FC : AC = gravity : centrifugal force. Complete the parallelogram FCEK. A particle at E is urged by its weight in the direction KE, with a force which may be expreſſed by FC or KE; and it is urged by the centrifugal force in the direction CE, with a force = AC or CE. By their combined action it is urged in the direction FE. Therefore, as the ſurface of ſtanding water is always at right angles to the action of gravity, that is, to the plumb-line, ſo the ſurface of the water in the revolving bucket is perpendicular to the action of the combined force FE.

Let NEO be the poſition of the bucket, which juſt holds all the water which it received as it paſſed the ſpout when not affected by the centrifugal force; and let NDO be its poſition when it would be empty. Let the vertical lines through D and E cut the circle deſcribed round C with the radius CF in the points H and I. Draw HC, IC, cutting the circle AOB in L and M. Make the arch $d'\partial$ equal to AL, and the arch $e'\varepsilon$ equal to AM: Then $C\partial$ and $C\varepsilon$ will be the poſitions of the bucket on the revolving wheel, correſponding to CDO and CEO on the wheel at reſt. Water will begin to run out at ε, and it will be all gone at ∂.—The demonſtration is evident.

The force which now urges the wheel is ſtill the weight *really* in the buckets: For though the water be urged in the direction and with the force FE, one of its conſtituents, CE, has no tendency to impel the wheel; and KE is the only impelling force.

It is but of late years that mills have been conſtructed or attended to with that accuracy and ſcientific ſkill which are neceſſary for deducing confidential concluſions from any experiments that can be made with them; and it is therefore no matter of wonder that the opinions of mill-wrights have been ſo different on this ſubject. There is a natural wiſh to ſee a machine moving briſkly; it has the appearance of activity: but a very ſlow motion always looks as if the machine were overloaded. For this reaſon mill-wrights have always yielded ſlowly, and with ſome reluctance, to the repeated advices of the mathematicians: but they have yielded; and we ſee them adopting maxims of conſtruction more agreeable to ſound theory; making their wheels of great breadth, and loading them with a great deal of work. Mr Euler ſays, that the performance of the beſt mill cannot exceed that of the worſt above $\frac{1}{3}$th: but we have ſeen a ſtream of water completely expended in driving a ſmall flax mill, which now drives a cotton mill of 4000 ſpindles, with all its carding, roving, and drawing machinery, beſides the lathes and other engines of the ſmith and carpenters workſhops, exerting a force not leſs than ten times what ſufficed for the flax mill.

The above diſcuſſion only demonſtrates in general the advantage of ſlow motion; but does not point out in any degree the relation between the rate of motion and the work performed, nor even the principles on which it depends. Yet this is a ſubject fit for a mathematical inveſtigation; and we would proſecute it in this place, if it were neceſſary for the improvement of practical mechanics. But we have ſeen that there is not, in the nature of things, a maximum of performance attached to any particular rate of motion which ſhould therefore be preferred. For this reaſon we omit this diſcuſſion of mere ſpeculative curioſity. It is very intricate: For we muſt not now expreſs the preſſure on the wheel by a *conſtant* pillar of water incumbent on the extremity of the horizontal arm, as we did before when we ſuppoſed the buckets completely filled; nor by a ſmaller *conſtant* pillar, correſponding to a ſmaller but equal quantity lying in every bucket. Each different velocity puts a different quantity of water into the bucket as it paſſes the ſpout; and this occaſions a difference in the place where the diſcharge is begun and completed. This circumſtance is ſome obſtacle to the advantages of very ſlow motions, becauſe it brings on the diſcharge ſooner. All this may indeed be expreſſed by a ſimple equation of eaſy management; but the whole proceſs of the mechanical diſcuſſion is both intricate and tedious, and the reſults are ſo much diverſified by the forms of the buckets, that they do not afford any rule of ſufficient generality to reward our trouble. The curious reader may ſee a very full inveſtigation of this ſubject in two diſſertations by Elvius in the Swediſh Tranſactions, and in the *Hydrodynamique* of Profeſſor Karſtner of Gottingen; who has abridged theſe Diſſertations of Elvius, and conſiderably improved the whole inveſtigation, and has added ſome compariſons of his deductions with the actual performance of ſome great works. Theſe compariſons, however, are not very ſatisfactory. There is alſo a valuable paper on this ſubject by Mr Lambert, in the Memoirs of the Academy of Berlin for the year 1775. From theſe diſſertations, and from the *Hydrodynamique* of the abbe Boſſut, the reader will get all that theory can teach of the relation between the preſſures of the power and work on the machine and the rates of its motion. The practical reader may reſt with confidence on the ſimple demonſtration we have given, that the performance is improved by diminiſhing the velocity.

All we have to do, therefore, is to load the machine, and thus to diminiſh its ſpeed, unleſs other phyſical circumſtances throw obſtacles in the way: but there are ſuch obſtacles. In all machines there are little inequalities of action that are unavoidable. In the action of a wheel and pinion, though made with the utmoſt judgment and care, there are ſuch inequalities. Theſe increaſe by the changes of form occaſioned by the wearing of the machine—much greater irregularities ariſe from the ſubſultory motions of cranks, ſtampers, and other parts which move unequally or reciprocally. A machine may be ſo loaded as juſt to be in equilibrio with its work, in the favourable poſition of its parts. When this changes into one leſs favourable, the machine may ſtop; if not, it at leaſt ſtaggers, hobbles, or works unequally. The rubbing parts bear long on each other, with enormous preſſures, and cut deep, and increaſe friction. Such ſlow motions muſt therefore be avoided. A little more velocity enables the machine to get over thoſe increaſed reſiſtances by its inertia, or the great quantity of motion inherent in it. Great machines poſſeſs this advantage in a ſuperior degree, and will therefore work ſteadily with a ſmaller velocity. Theſe circumſtances are hardly ſuſceptible of mathematical diſcuſſion, and our beſt reliance is on well directed experience.

For this purpoſe, the reader will do well to peruſe with care the excellent paper by Mr Smeaton in the Philoſophical Tranſactions for 1759. This diſſertation contains a numerous liſt of experiments, moſt judiciouſly contrived by him, and executed with the accuracy and attention to the moſt important circumſtances, which is to be obſerved in all that gentleman's performances.

It is true, theſe experiments were made with ſmall models; and we muſt not, without great caution, transfer the reſults of ſuch experiments to large works. But we may ſafely transfer the laws of variation which reſult from a variation of circumſtances, although we muſt not adopt the abſolute quantities of the variations themſelves. Mr Smeaton was fully aware of the limitations to which concluſions drawn from experiments on models are ſubject, and has made the applications with his uſual ſagacity.

His general inference is, that, in ſmaller works, the rim of the overſhot-wheel ſhould not have a greater velocity than three feet in a ſecond; but that larger mills may be allowed a greater velocity than this. When every thing is executed in the beſt manner, he ſays that the work performed will amount to fully two-thirds of the power expended; that is, that three cubic feet of water deſcending from any height will raiſe two to the ſame height.

It is not very eaſy to compare theſe deductions with obſervations on large works; becauſe there are few caſes where we have good meaſures of the reſiſtances oppoſed by the work performed by the machine. Mills employed for pumping water afford the beſt opportunities. But the inertia of their working gear diminiſhes their uſeful performance very ſenſibly; becauſe their great beams, pump-rods, &c. have a reciprocating motion, which muſt be deſtroyed, and produced anew in every ſtroke. We have examined ſome machines of this kind which are eſteemed good ones; and we find few of them whoſe performance exceeds one half of the power expended.

By comparing other mills with theſe, we get the beſt information of their reſiſtances. The compariſon with mills worked by Watt and Boulton's ſteam-engines is perhaps a better meaſure of the reſiſtances oppoſed by different kinds of work, becauſe their power is very diſtinctly known. We have been informed by one of the moſt eminent engineers, that a ton and a half of water per minute falling one foot will grind and dreſs one buſhel of wheat per hour. This is equivalent to 9 tons falling 10 feet.

If an overſhot-wheel oppoſed no reſiſtance, and only one bucket were filled, the wheel would acquire the velocity due to a fall through the whole height. But when it is in this ſtate of accelerated motion, if another bucket of water is delivered into it, its motion muſt be checked at the firſt, by the neceſſity of dragging forward this water. If the buckets fill in ſucceſſion as they paſs the ſpout, the velocity acquired by an unreſiſting wheel is but half of that which one bucket would give. In all caſes, therefore, the velocity is diminiſhed by the inertia of the entering water when it is ſimply laid into the upper buckets. The performance will therefore be improved by delivering the water on the wheel with that velocity with which the wheel is really moving. And as we cannot give the direction of a tangent to the wheel, the velocity with which it is delivered on the wheel muſt be ſo much greater than the intended velocity of the rim, that it ſhall be preciſely equal to it when it is eſtimated in the direction of the tangent. Three or four inches of fall are ſufficient for this purpoſe; and it ſhould never be neglected, for it has a very ſenſible influence on the performance. But it is highly improper to give it more than this, with the view of impelling the wheel by its ſtroke. For even although it were proper to employ part of the fall in this way (which we ſhall preſently ſee to be very improper), we cannot procure this impulſe; becauſe the water falls among other water, or it ſtrikes the boards of the wheel with ſuch obliquity that it cannot produce any ſuch effect.

It is a much debated queſtion among mill-wrights, Whether the diameter of the wheel ſhould be ſuch as that the water will be delivered at the top of the wheel? or larger, ſo that the water is received at ſome diſtance from the top, where it will act more perpendicularly to the arm? We apprehend that the obſervations formerly made will decide in favour of the firſt practice. The ſpace below, where the water is diſcharged from the wheel, being proportional to the diameter of the wheel, there is an undoubted loſs of fall attending a large wheel; and this is not compenſated by delivering the water at a greater diſtance from the perpendicular. We ſhould therefore recommend the uſe of the whole deſcending ſide, and make the diameter of the wheel no greater than the fall, till it is ſo much reduced that the centrifugal force begins to produce a ſenſible effect. Since the rim can hardly have a ſmaller velocity than three feet per ſecond, it is evident that a ſmall wheel muſt revolve more rapidly. This made it proper to inſert the determination that we have given, of the loſs of power produced by the centrifugal force. But even with this in view, we ſhould employ much ſmaller wheels than are generally done on ſmall falls. Indeed the loſs of water at the bottom may be diminiſhed, by nicely fitting the arch which ſurrounds the wheel, ſo as not to allow the water to eſcape by the ſides or bottom. While this improvement remains in good order, and the wheel entire, it produces a very ſenſible effect; but the paſſage widens continually by the wearing of the wheel. A bit of ſtick or ſtone falling in about the wheel tears off part of the ſhrouding or bucket, and froſty weather frequently binds all faſt. It therefore ſeldom anſwers expectations. We have nothing to add on this caſe to what we have already extracted from Mr Smeaton's Diſſertation on the Subject of Breaſt or half Overſhot Wheels.

There is another form of wheel by which water is made to act on a machine by its weight, which merits conſideration. This is known in this country by the name of *Barker's mill*, and has been deſcribed by Deſaguliers, vol. ii. p. 460. It conſiſts of an upright pipe or trunk AB (fig. 11.), communicating with two horizontal branches BC, B *c*, which have a hole C *c* near their ends, opening in oppoſite directions, at right angles to their lengths. Suppoſe water to be poured in at the top from the ſpout F, it will run out by the holes C and *c* with the velocity correſponding to the depth of theſe holes under the ſurface. The conſequence of this muſt be, that the arms will be preſſed backwards; for there is no ſolid ſurface at the hole C, on which the lateral preſſure of the water can be exerted, while it acts with its full force on the oppoſite ſide of the arm. This unbalanced preſſure is equal to the weight of a column having the orifice for its baſe, and twice the depth under the ſurface of the water in the trunk for its height. This meaſure of the height may ſeem odd, becauſe if the orifice were ſhut, the preſſure on it is the weight of a column reaching from the ſurface. But when it is open, the water iſſues with nearly the velocity acquired by falling from the ſurface, and the quantity of motion produced is that of a column of twice this length, moving with this velocity. This is actually produced by the preſſure of the fluid, and muſt therefore be accompanied by an equal reaction. Fig. 11.

Now ſuppoſe this apparatus ſet on the pivot E, and to have a ſpindle AD above the trunk, furniſhed with a cylindrical bobbin D, having a rope wound round it, and paſſing over a pulley G. A weight W may be ſuſpended there, which may balance this backward preſſure. If the weight be too ſmall for this purpoſe, the retrograde motion of the arms will wind up the cord, and raiſe the weight; and thus we obtain an acting machine, employing the preſſure of the water, and applicable to any purpoſe. A runner millſtone may be put on the top of the ſpindle; and we ſhould then produce a flour mill of the utmoſt ſimplicity, having neither wheel nor pinion, and ſubject to hardly any wear. It is ſomewhat ſurpriſing, that although this was invented at the beginning of this century, and appears to have ſuch advantage in point of ſimplicity, it has not come into uſe. So little has Dr Deſaguliers's account been attended to (although it is mentioned by him as an excellent machine, and as highly inſtructive to the hydrauliſt), that the ſame invention was again brought forward by a German profeſſor (Segner) as his own, and has been honoured by a ſeries of elaborate diſquiſitions concerning its theory and performance by Euler and by John Bernoulli. Euler's Diſſertations are to be found in the Memoirs of the Academy of Berlin, 1751, &c. and in the *Nov. Comment. Petropol.* tom. vi. Bernoulli's are at the end of his Hydraulics. Both theſe authors agree in ſaying, that this machine excels all other methods of employing the force of water. Simple as it appears, its true theory, and the beſt form of conſtruction, are moſt abſtruſe and delicate ſubjects; and it is not eaſy to give ſuch an account of its principles as will be underſtood by an ordinary reader.

We ſee, in general, that the machine muſt preſs backwards; and little inveſtigation ſuffices for underſtanding the intenſity of this preſſure, when the machine is at reſt. But when it is allowed to run backwards, withdrawing itſelf from the preſſure, the intenſity of it is diminiſhed; and if no other circumſtances intervened, it might not be difficult to ſay what particular preſſure correſponded to any rate of motion. Accordingly, Deſaguliers, preſuming on the ſimplicity of the machine, affirms the preſſure to be the weight of a column, which would produce a velocity of efflux equal to the difference of the velocity of the fluid and of the machine; and hence he deduces, that its performance will be the greateſt poſſible, when its retrograde velocity is one-third of the velocity acquired by falling from the ſurface, in which caſe, it will raiſe $\frac{8}{27}$ths of the water expended to the ſame height, which is double of the performance of a mill acted on by the impulſe of water.

But this is a very imperfect account of the operation. When the machine (conſtructed exactly as we have deſcribed) moves round, the water which iſſues deſcends in the vertical trunk, and then, moving along the horizontal arms, partakes of this circular motion. This excites a centrifugal force, which is exerted againſt the ends of the arms by the intervention of the fluid. The whole fluid is ſubjected to this preſſure (increaſing for every ſection acroſs the arm in the proportion of its diſtance from the axis), and every particle is preſſed with the accumulated centrifugal forces of all the ſections that are nearer to the axis. Every ſection therefore ſuſtains an actual preſſure proportional to the ſquare of its diſtance from the axis. This increaſes the velocity of efflux, and this increaſes the velocity of revolution; and this mutual co-operation would ſeem to terminate in an infinite velocity of both motions. But, on the other hand, this circular motion muſt be given anew to every particle of water as it enters the horizontal arm. This can be done only by the motion already in the arm, and at its expence. Thus there muſt be a velocity which cannot be overpaſſed even by an unloaded machine. But it is alſo plain, that by making the horizontal arm very capacious, the motion of the water from the axis to the jet may be made very ſlow, and much of this diminution of circular motion prevented. Accordingly, Euler has recommended a form by which this is done in the moſt eminent degree. His machine conſiſts of a hollow conoidal ring, of which fig. 12. is a ſection. The part AH *h a* is a ſort of a funnel baſon, which receives the water from the ſpout F; not in the direction pointing towards the axis, but in the direction, and with the preciſe velocity, of its motion. This prevents any retardation by dragging forward the water. The water then paſſes down between the outer conoid AC *c a* and the inner conoid HG *g h* along ſpiral channels formed by partitions ſoldered to both conoids. The curves of theſe channels are determined by a theory which aims at the annihilation of all unneceſſary and improper motions of the water, but which is too abſtruſe to find a place here. The water thus conducted arrives at the bottom C G, *c g*. On the the outer circumference of this bottom are arranged a number of ſpouts (one for each channel), which are all directed one way in tangents to the circumference. Fig. 12.

Adopting the common theory of the reaction of fluids, this ſhould be a very powerful machine, and ſhould raiſe $\frac{8}{27}$ths of the water expended. But if we admit the re-

action

Fig. 13.

action to be equal to the force of the iſſuing fluid (and we do not ſee how this can be refuſed), the machine muſt be nearly twice as powerful. We therefore repeat our wonder, that it has not been brought into uſe. But it appears that no trial has been made even of a model; ſo that we have no experiments to encourage an engineer to repeat the trial. Even the late author, Profeſſor Segner, has not related any thing of this kind in his *Exercitationes Hydraulicæ*, where he particularly deſcribes the machine. This remiſſneſs probably has proceeded from fixing the attention on Euler's improved conſtruction. It is plain that this muſt be a moſt cumbrous maſs, even in a ſmall ſize requiring a prodigious veſſel, and carrying an unwieldy load. If we examine the theory which recommends this conſtruction, we find that the advantages, though real and ſenſible, bear but a ſmall proportion to the whole performance of the ſimple machine as invented by Dr Barker. It is therefore to be regretted, that engineers have not attempted to realize the firſt project. We beg leave to recommend it, with an additional argument taken from an addition made to it by Mr Mathon de la Cour, in Rozier's *Journal de Phyſique*, January and Auguſt 1775. This gentleman brings down a large pipe FEH (fig. 13.) from a reſervoir, bends it upward at H, and introduces it into two horizontal arms DA, DB, which have an upright ſpindle DK, carrying a millſtone in the ſtyle of Dr Barker's mill. The ingenious mechanician will have no difficulty of contriving a method of joining theſe pipes, ſo as to permit a free circular motion without loſing much water. The operation of the machine in this form is evident. The water, preſſed by the column FG, flows out at the holes A and B, and the unbalanced preſſure on the oppoſite ſides of the arms forces them round. The compendiouſneſs and other advantages of this conſtruction are moſt ſtriking, allowing us to make uſe of the greateſt fall without any increaſe of the ſize of the machine. It undoubtedly enables us to employ a ſtream of water too ſcanty to be employed in any other form. The author gives the dimenſions of an engine which he had ſeen at Bourg Argental. AB is 92 inches, and its diameter 3 inches; the diameter of each orifice is $1\frac{1}{6}$; FG is 21 feet; the pipe D was fitted into C by grinding; and the internal diameter of D is 2 inches.

When the machine was performing no work, or was unloaded, and emitted water by one hole only, it made 115 turns in a minute. This gives a velocity of 46 feet per ſecond for the hole. This is a curious fact: For the water would iſſue from this hole at reſt with the velocity of $37\frac{1}{6}$. This great velocity (which was much leſs than the velocity with which the water actually quitted the pipe) was undoubtedly produced by the prodigious centrifugal force, which was nearly 17 times the weight of the water in the orifice.

The empty machine weighed 80 pounds, and its weight was half-ſupported by the upper preſſure of the water, ſo that the friction of the pivots was much diminiſhed. It is a pity that the author has given no account of any work done by the machine. Indeed it was only working ventilators for a large hall. His theory by no means embraces all its principles, nor is it well-founded.

We think that the free motion round the neck of the feeding-pipe, without any loſs of water or any conſiderable friction, may be obtained in the following manner: AB (fig. 14.) repreſents a portion of the revolving horizontal pipe, and CE*ec* part of the feeding pipe. The neck of the firſt is turned truly cylindrical, ſo as to turn eaſily, but without ſhake, in the collar C*c* of the feeding-pipe, and each has a ſhoulder which may ſupport the other. That the friction of this joint may not be great, and the pipes deſtroy each other by wearing, the horizontal pipe has an iron ſpindle EF, fixed exactly in the axis of the joint, and reſting with its pivot F in a ſtep of hard ſteel, fixed to the iron bar GH, which goes acroſs the feeding-pipe, and is firmly ſupported in it. This pipe is made bell-ſhaped, widening below. A collar or hoſe of thin leather is fitted to the inſide of this pipe, and is repreſented (in ſection) by LKM*m k l*. This is kept in its place by means of a metal or wooden ring N*n*, thin at the upper edge, and taper ſhaped. This is drawn in above the leather, and ſtretches it, and cauſes it to apply to the ſide of the pipe all around. There can be no leakage at this joint, becauſe the water will preſs the leather to the ſmooth metal pipe; nor can there be any ſenſible friction, becauſe the water gets at the edge of the leather, and the whole unbalanced preſſure is at the ſmall crevice, between the two metal ſhoulders. Theſe ſhoulders need not touch, ſo that the friction muſt be inſenſible. We imagine that this method of tightening a turning joint may be uſed with great advantage in many caſes.

We have only further to obſerve on this engine, that any imperfection by which the paſſage of the water is diminiſhed or obſtructed produces a ſaving of water which is in exact proportion to the diminution of effect. The only inaccuracy that is not thus compenſated is when the jets are not at right angles to the arms.

We repeat our wiſhes, that engineers would endeavour to bring this machine into uſe, ſeeing many ſituations where it may be employed to great advantage. Suppoſe, for inſtance, a ſmall ſupply of water from a great height applied in this manner to a centrifugal pump, or to a hair belt paſſing over a pulley, and dipping in the water of a deep well. This would be a hydraulic machine exceeding all others in ſimplicity and durability, though inferior in effect to ſome other conſtructions.

2. *Of Underſhot Wheels.*

All wheels go by this name where the motion of the water is quicker than that of the partitions or boards of the wheel, and it therefore impels them. Theſe are called the *float-boards*, or *floats*, of an underſhot wheel. The water, running in a mill-row, with a velocity derived from a head of water, or from a declivity of channel, ſtrikes on theſe floats, and occaſions, by its deflections ſidewiſe and upwards, a preſſure on the floats ſufficient for impelling the wheel.

There are few points of practical mechanics that have been more conſidered than the action of water on the floats of a wheel; hardly a book of mechanics being ſilent on the ſubject. But the generality of them, at leaſt ſuch as are intelligible to perſons who are not very much converſant in dynamical and mathematical diſcuſſion, have hardly done any thing more than copied the earlieſt deductions from the ſimple theory of the reſiſtance of fluids. The conſequence has been, that our practical knowledge is very imperfect; and it is ſtill chiefly from experience that we muſt learn the performance of underſhot wheels. Unfortunately this ſtops their improvement; becauſe thoſe who have the only opportunities of making the experiments are not ſufficiently acquainted with the principles of hydraulics, and are apt to aſcribe differences in their performance to trifling noſtrums in their conſtruction, or in the manner of applying the impulſe of the water.

We have ſaid ſo much on the imperfection of our theories of the impulſe of fluids in the article *RESISTANCE of Fluids*, that we need not repeat here the defects of the common explanations of the motions of underſhot wheels. The part of this theory of the impulſe of fluids which agrees beſt with obſervation is, *that the impulſe is in the duplicate proportion of the velocity with which the water ſtrikes the float.* That is, if v be the velocity of the ſtream, and u the velocity of the float, we ſhall have F, the impulſe on the float when held faſt to its impulſe f on the float moving with the velocity u, as v^2 to $\overline{v-u}^2$, and $f = \text{F} \times \frac{\overline{v-u}^2}{v^2}$.

This is the preſſure acting on the float, and urging the wheel round its axis. The wheel muſt yield to this motion, if the reſiſtance of the work does not exert a ſuperior preſſure on the float in the oppoſite direction. By yielding, the float withdraws from the impulſe, and this is therefore diminiſhed. The wheel accelerates, the reſiſtances increaſe, and the impulſes diminiſh, till they become an exact balance for the reſiſtances. The motion now remains uniform, and the momentum of impulſe is equal to that of reſiſtance. The performance of the mill therefore is determined by this; and, whatever be the conſtruction of the mill, its performance is beſt when the momentum of impulſe is greateſt. This is had by multiplying the preſſure on the float by its velocity. Therefore the momentum will be expreſſed by $\text{F} \times \frac{\overline{v-u}^2}{v^2} \times u$. But ſince F and v^2 are conſtant quantities, the momentum will be proportional to $u \times \overline{v-u}^2$. Let x repreſent the relative velocity. Then $v-x$ will be $=u$, and the momentum will be proportional to $\overline{v-x} \times x^2$, and will be a maximum when $\overline{v-x} \times x^2$ is a maximum, or when $v x^2 - x^3$ is a maximum. This will be diſcovered by making its fluxion $=o$. That is,

$$2 v x \dot{x} - 3 x^2 \dot{x} = o.$$

and $2 v x - 3 x^2 = o$

or $2 v - 3 x = o$

and $2 v = 3 x$, and $x = \frac{2}{3} v$; and therefore $v-x$, or $u, = \frac{1}{3} v$. That is, the velocity of the float muſt be one third of the velocity of the ſtream. It only remains to ſay what is the abſolute preſſure on the float thus circumſtanced. Let the velocity v be ſuppoſed to ariſe from the preſſure of a head of water h. The common theory teaches that the impulſe on a given ſurface S at reſt is equal to the weight of a column h S; put this in place of F, and $\frac{4}{9} v^2$ in place of $\overline{v-u}^2$ and $\frac{1}{3} v$ for u. This gives us $\text{S} h \times \frac{4}{27} v$ for the momentum. Now the power expended is $\text{S} h v$, or the column S h moving with the velocity v. Therefore the greateſt performance of an underſhot wheel is equivalent to raiſing $\frac{4}{27}$ of the water that drives it to the ſame height.

But this is too ſmall an eſtimation; for the preſſure exerted on a plane ſurface, ſituated as the float of a mill-wheel, is conſiderably greater than the weight of the column S h. This is nearly the preſſure on a ſurface wholly immerſed in the fluid. But when a ſmall vein ſtrikes a larger plane, ſo as to be deflected on all ſides in a thin ſheet, the impulſe is almoſt double of this. This is in ſome meaſure the caſe in a mill wheel. When the ſtream ſtrikes it, it is heaped up along its face, and falls back again—and during this motion it is acting with a hydroſtatic preſſure on it. When the wheel dips into an open river, this accumulation is leſs remarkable, becauſe much eſcapes laterally. But in a mill courſe it may be conſiderable.

We have conſidered only the action on one float, but ſeveral generally act at once. The impulſe on moſt of them muſt be oblique, and is therefore leſs than when the ſame ſtream impinges perpendicularly; and this diminution of impulſe is, by the common theory, in the proportion of the ſine of the obliquity. For this reaſon it is maintained, that the impulſe of the whole ſtream on the loweſt floatboard, which is perpendicular to the ſtream, is equal to the ſum of the impulſes made on all the floats which then dip into the water; or that the impulſe on any oblique float is preciſely equal to the impulſe which that part of the ſtream would have made on the loweſt floatboard had it not been interrupted. Therefore it has been recommended to make ſuch a number of floatboards, that when one of them is at the bottom of the wheel, and perpendicular to the ſtream, the next in ſucceſſion ſhould be juſt entering into the water. But ſince the impulſe on a float by no means annihilates all the motion of the water, and it bends round it and hits the one behind with its remaining force, there muſt be ſome advantage gained by employing a greater number of floats than this rule will permit. This is abundantly confirmed by the experiments of Smeaton and Boſſut. Mr Boſſut formed three or four ſuppoſitions of the number of floats, and calculated the impulſe on each; according to the obſervations made in a courſe of experiments made by the Academy of Sciences, and inſerted by us in the article *RESISTANCE of Fluids*; and when he ſummed them up, and compared the reſults with his experiments, he found the agreement very ſatisfactory. He deduces a general rule, that if the velocity of the wheel is one-third of that of the ſtream, and if 72 degrees of the circumference are immerſed in the ſtream, the wheel ſhould have 36 floats. Each will dip one-fifth of the radius. The velocity being ſtill ſuppoſed the ſame, there ſhould be more or fewer floats according as the arch is leſs or greater than 72 degrees.

Such is the theory, and ſuch are the circumſtances which it leaves undetermined. The accumulation of the water on a floatboard, and the force with which it may ſtill ſtrike another, are too intricate to be aſſigned with any tolerable preciſion: For ſuch reaſons we muſt acknowledge that the theory of underſhot wheels is ſtill very imperfect, and that recourſe muſt be had to experience for their improvement. We therefore ſtrongly recommend the peruſal of Mr Smeaton's experiments on underſhot wheels, contained in the ſame diſſertation with thoſe we have quoted on overſhot wheels. We have only to obſerve, that to an ordinary reader the experiments will appear too much in favour of underſhot wheels. His aim is partly to eſtabliſh a theory, which will ſtate the relation between their performance and the velocity of the ſtream, and partly to ſtate the relation between the power expended and the work done. The velocity in his experiments is always conſiderably below that which a body would acquire by falling from the ſurface of the head of water; or it is the velocity acquired by a ſhorter fall. Therefore if we eſtimate the power expended by the quantity of water multiplied by this diminiſhed fall, we ſhall make it too ſmall; and the difference in ſome caſes is very great: yet, even with theſe conceſſions, it appears that the utmoſt performance of an underſhot wheel does not ſurpaſs the raiſing one-third of the expended water to the place from which it came. It is therefore far inferior to an overſhot wheel expending the ſame power; and Mr Belidor has led engineers into very miſtaken maxims of conſtruction, by ſaying that overſhot wheels ſhould be given up, even in the caſe of great falls, and that we ſhould always bring on the water from a ſluice in the very bottom of the dam, and bring it to the wheel with as great velocity as poſſible. Mr Smeaton alſo ſays, that the maximum takes place when the velocity of the wheel is two-fifths of that of the ſtream, inſtead of two-ſixths according to the theory; and this agrees with the experiments of Boſſut. But he meaſured the velocity by means of the quantity of water which run paſt. This muſt give a velocity ſomewhat too ſmall; as will appear by attending to Buat's obſervations on the ſuperficial, the mean, and the bottom velocities.

The reſt of his obſervations are moſt judicious, and well adapted to the inſtruction of practitioners. We have only to add to them the obſervations of Des Parcieux and Boſſut, who have evinced, by very good experiments, that there is a very ſenſible advantage gained by inclining the floatboards to the radius of the wheel about 20 degrees, ſo that the loweſt floatboard ſhall not be perpendicular, but have its point turned up the ſtream about 20 degrees. This inclination cauſes the water to heap up along the floatboard, and act by its weight. The floats ſhould therefore be made much broader than the vein of water interrupted by them is deep.

Some engineers, obſerving the great ſuperiority of overſhot wheels above underſhot wheels driven by the ſame expence of power, have propoſed to bring the water home to the bottom of the wheel on an even bottom, and to make the floatboard no deeper than the aperture of the ſluice, which would permit the water to run out. The wheel is to be fitted with a cloſe ſole and ſides, exactly fitted to the end of this trough, ſo that if the wheel is at reſt, the water may be dammed up by the ſole and floatboard. It will therefore preſs forward, the floatboard with the whole force of the head of water. But this cannot anſwer; for if we ſuppoſe no floatboards, the water will flow out at the bottom, propelled in the manner thoſe perſons ſuppoſe; and it will be ſupplied from behind, the water coming *ſlowly* from all parts of the trough to the hole below the wheel. But now add the floats, and ſuppoſe the wheel in motion with the velocity that is expected. The other floats muſt drag into motion all the water which lies between them, giving to the greateſt part of it a motion vaſtly greater than it would have taken in conſequence of the preſſure of the water behind it; and the water out of the reach of the floats will remain ſtill, which it would not have done independent of the floatboards above it, becauſe it would have contributed to the expence of the hole. The motion therefore which the wheel will acquire by this conſtruction muſt be ſo different from what is expected, that we can hardly ſay what it will be.

We are therefore perſuaded, that the beſt way of delivering the water on an underſhot wheel in a cloſe mill-courſe is, to let it ſlide down a very ſmooth channel, without touching the wheel till near the bottom, where the wheel ſhould be exactly fitted to the courſe; or, to make the floats exceedingly broader than the depth of the vein of water which glides down the courſe, and allow it to be partly intercepted by the firſt floats, and heap up along them, acting by its weight, after its impulſe has been expended. If the bottom of the courſe be an arch of a circle deſcribed with a radius much greater than that of the wheel, the water which ſlides down will be thus gradually intercepted by the floats.

Attempts have been made to conſtruct water-wheels which receive the impulſe obliquely, like the ſails of a common wind-mill. This would, in many ſituations, be a very great acquiſition. A very ſlow but deep river could in this manner be made to drive our mills; and although much power is loſt by the obliquity of the impulſe, the remainder may be very great. It is to be regretted, that theſe attempts have not been more zealouſly proſecuted; for we have no doubt of their ſucceſs in a very ſerviceable degree. Engineers have been deterred, becauſe when ſuch wheels are plunged in an open ſtream, their lateral motion is too much impeded by the motion of the ſtream. We have ſeen one, however, which was very powerful: It was a long cylindrical frame, having a plate ſtanding out from it about a foot broad, and ſurrounding it with a very oblique ſpiral like a cork-ſcrew. This was plunged about one-fourth of its diameter (which was about 12 feet), having its axis in the direction of the ſtream. By the work which it was performing, it ſeemed more powerful than a common wheel which occupied the ſame *breadth* of the river. Its length was not leſs than 20 feet: it might have been twice as much, which would have doubled its power, without occupying more of the water-way. Perhaps ſuch a ſpiral, continued to the very axis, and moving in a hollow canal wholly filled by the ſtream, might be a very advantageous way of employing a deep and ſlow ſtream.

But mills with oblique floats are moſt uſeful for employing ſmall ſtreams, which can be delivered from a ſpout with a great velocity. Mr Boſſut has conſidered theſe with due attention, and aſcertained the beſt modes of conſtruction. There are two which have nearly equal performances: 1. The vanes being placed like thoſe of a wind-mill, round the rim of a horizontal or vertical wheel, and being made much broader than the vein of water which is to ſtrike them, let the ſpout be ſo directed that the vein may ſtrike them perpendicularly. By this meaſure it will be ſpread about on the vane in a thin ſheet, and exert a preſſure nearly equal to twice the weight of a column whoſe baſe is the orifice of the ſpout, and whoſe height is the fall producing the velocity.

Mills of this kind are much in uſe in the ſouth of Europe. The wheel is horizontal, and the vertical axis carries the millſtone; ſo that the mill is of the utmoſt ſimplicity: and this is its chief recommendation; for its power is greatly inferior to that of a wheel conſtructed in the uſual manner.

2. The vanes may be arranged round the rim of the

wheel, not like the ſails of a wind-mill, but in planes inclined to the radii, but parallel to the axis, or to the planes paſſing through the axis. They may either ſtand on a ſole, like the oblique floats recommended by De Parcieux, as above mentioned: or they may ſtand on the ſide of the rim, not pointing to the axis, but aſide from it.

This diſpoſition will admit the ſpout to be more conveniently diſpoſed either for a horizontal or a vertical wheel.

We ſhall conclude this article by deſcribing a contrivance of Mr Burns, the inventor of the double bucketed wheel, for fixing the arms of a water-wheel. It is well known to mill-wrights that the method of fixing them by making them to paſs through the axle, weakens it exceedingly, and by lodging water in the joint, ſoons cauſes it to rot and fail. They have, therefore, of late years put caſt-iron flanches on the axis, to which each arm is bolted: or the flanches are ſo faſhioned as to form boxes, ſerving as mortiſes to receive the ends of the arms. Theſe anſwer the purpoſe completely, but are very expenſive; and it is found that arms of fir bolted into flanches of iron, are apt to work looſe. Mr Burns has made wooden flanches of a very curious conſtruction, which are equally firm, and coſt much leſs than the iron ones.

Fig. 15.

This flanch conſiſts of eight pieces, four of which compoſe the ring repreſented in fig. 15. meeting in the joints *a b*, *a b*, *a b*, *a b*, directed to the centre O. The other four are covered by theſe, and their joints are repreſented by the dotted lines $\alpha\beta$, $\alpha\beta$, $\alpha\beta$, $\alpha\beta$. Theſe two rings break joint in ſuch a manner that an arm MN is contained between the two neareſt joints $a' b'$ of the one, and $\alpha' \beta'$ of the other. The tenon formed on the one end of the arm A, &c. is of a particular ſhape: one ſide, GF, is directed to the centre O; the other ſide, BCDE, has a ſmall ſhoulder BC; then a long ſide CD directed to the centre O; and then a third part DE parallel to GF, or rather diverging a little from it, ſo as to make up at E the thickneſs of the ſhoulder BC; that is, a line from B to E would be parallel to CD. This ſide of the tenon fits exactly to the correſponding ſide of the mortiſe; but the mortiſe is wider on the other ſide, leaving a ſpace GFK *h* a little narrower at FK than at G *h*. Theſe tenons and mortiſes are made extremely true to the ſquare; the pieces are put round the axle, with a few blocks or wedges of ſoft wood put between them and the axle, leaving the ſpace empty oppoſite to the place of each arm, and firmly bolted together by bolts between the arm mortiſes. The arms are then put in, and each is preſſed home to the ſide CDE, and a wedge HF of hard wood is then put into the empty part of the mortiſe and driven home. When it comes through the flanch and touches the axle, the part which has come through is cut off with a thin chiſel, and the wedge is driven better home. The ſpaces under the ends of the arms are now filled with wedges, which are driven home from oppoſite ſides, till the circle of the arms ſtands quite perpendicular on the axle, and all is faſt. It needs no hoops to keep it together, for the wedging it up round the axle makes the two half rings draw cloſe on the arms, and it cannot ſtart at its own joints till it cruſhes the arms. Hoops, however, can do no harm, when all is once wedged up, but it would be improper to put them on before this be done.

A very curious hydraulic machine was erected at Zurich by H. Andreas Wirtz, a tinplate worker of that place. The invention ſhows him to be a perſon of very uncommon mechanical knowledge and ſagacity. As it is a machine which operates on a principle widely different from all other hydraulic machines, and is really excellent in its kind, we preſume that our readers will not be diſpleaſed with ſome account of it.

Fig. 16.

Fig. 16. is a ſketch of the ſection of the machine, as it was firſt erected by Wirtz at a dyehouſe in Limmat, in the ſuburbs or vicinity of Zurich. It conſiſts of a hollow cylinder, like a very large grindſtone, turning on a horizontal axis, and partly plunged in a ciſtern of water. The axis is hollow at one end, and communicates with a perpendicular pipe CBZ′, part of which is hid by the cylinder. This cylinder or drum is formed into a ſpiral canal by a plate coiled up within it like the main ſpring of a watch in its box; only the ſpires are at a diſtance from each other, ſo as to form a conduit for the water of uniform width. This ſpiral partition is well joined to the two ends of the cylinder, and no water eſcapes between them. The outermoſt turn of the ſpiral begins to widen about three-fourths of a circumference from the end, and this gradual enlargement continues from Q to S nearly a ſemicircle: this part may be called the HORN. It then widens ſuddenly, forming a SCOOP or ſhovel SS′. The cylinder is ſupported ſo as to dip ſeveral inches into the water, whoſe ſurface is repreſented by VV′.

When this cylinder is turned round its axis in the direction ABEO, as expreſſed by the two darts, the ſcoop SS′ dips at V′, and takes up a certain quantity of water before it emerges again at V. This quantity is ſufficient to fill the taper part SQ, which we have called the HORN; and this is nearly equal in capacity to the outermoſt uniform ſpiral round.

After the ſcoop has emerged, the water paſſes along the ſpiral by the motion of it round the axis, and drives the air before it into the riſing-pipe, where it eſcapes.— In the mean time, air comes in at the mouth of the ſcoop; and when the ſcoop again dips into the water, it again takes in ſome. Thus there is now a part filled with water and a part filled with air. Continuing this motion, we ſhall receive a ſecond round of water and another of air. The water in any turn of the ſpiral will have its two ends on a level; and the air between the ſucceſſive columns of water will be in its natural ſtate; for ſince the paſſage into the riſing-pipe or MAIN is open, there is nothing to force the water and air into any other poſition. But ſince the ſpires gradually diminiſh in their length, it is plain that the column of water will gradually occupy more and more of the circumference of each. At laſt it will occupy a complete turn of ſome ſpiral that is near the centre; and when ſent farther in, by the continuance of the motion, ſome of it will run back over the top of the ſucceeding ſpiral. Thus it will run over at K 4 into the right-hand ſide of the third ſpiral. Therefore it will puſh the water of this ſpire backwards, and raiſe its other end, ſo that it alſo will run over backwards *before* the next turn be completed. And this change of diſpoſition will at laſt reach the firſt or outermoſt ſpiral, and ſome water will run over into the horn and ſcoop, and finally into the ciſtern.

But as ſoon as water gets into the riſing-pipe, and riſes a little in it, it ſtops the eſcape of the air when the next ſcoop of water is taken in. Here are now two columns of water acting againſt each other by hydroſtatic preſſure and the intervening column of air. They muſt compreſs the air between them, and the water and air columns will now be unequal. This will have a general tendency to keep the whole water back, and cauſe it to be higher on the left or riſing ſide of each ſpire than on the right deſcending ſide. The exceſs of height will be juſt ſuch as produces the compreſſion of the air between that and the preceding column of water. This will go on increaſing as the water mounts in the riſing-pipe; for the air next to the riſing-pipe is compreſſed at its inner end with the weight of the whole column in the main. It muſt be as much compreſſed at its outer end. This muſt be done by the water column without it; and this column exerts this preſſure partly by reaſon that *its* outer end is higher than its inner end, and partly by the tranſmiſſion of the preſſure on its outer end by air, which is ſimilarly compreſſed from without. And thus it will happen that each column of water, being higher at its outer than at its inner end, compreſſes the air on the water column beyond or within it, which tranſmits this preſſure to the air beyond it, adding to it the preſſure ariſing from its own want of level at the ends. Therefore the greateſt compreſſion, viz. that of the air next the main, is produced by *the ſum of all the tranſmitted preſſures*; and theſe are the ſum of all the differences between the elevation of the inner ends of the water columns above their outer ends: and the height to which the water will riſe in the main will be juſt equal to this ſum.

Draw the horizontal lines K'K 1, K'K 2, K'K 3, &c. and *m n*, *m n*, *m n*, &c. Suppoſe the left-hand ſpaces to be filled with water, and the right-hand ſpaces to be filled with air. There is a certain gradation of compreſſion which will keep things in this poſition. The ſpaces evidently decreaſe in arithmetical progreſſion; ſo do the hydroſtatic heights and preſſures of the water columns. If therefore the air be denſe in the ſame progreſſion, all will be in hydroſtatical equilibrium. Now this is evidently producible by the mere motion of the machine; for ſince the denſity and compreſſion in each air column is ſuppoſed inverſely as the bulk of the column, the abſolute quantity of air is the ſame in all; therefore the column firſt taken in will paſs gradually inwards, and the increaſing compreſſion will cauſe it to occupy preciſely the whole right-hand ſide of every ſpire. The gradual diminution of the water columns will be produced during the motion by the water running over backwards at the top, from ſpire to ſpire, and at laſt coming out by the ſcoop.

It is evident that this diſpoſition of the air and water will raiſe the water to the greateſt height, becauſe the hydroſtatic height of each water column is the greateſt poſſible, viz. the diameter of the ſpire. This diſpoſition may be obtained in the following manner: Take CL to CB as the denſity of the external air to its denſity in the laſt column next the riſing-pipe or main; that is, make CL to CB as 33 feet (the height of the column of water which balances the atmoſphere), to the ſum of 33 feet and the height of the riſing-pipe. Then divide BL into ſuch a number of turns, that the ſum of their diameters ſhall be equal to the height of the main; then bring a pipe ſtraight from L to the centre C. The reaſon of all this is very evident.

But when the main is very high, this conſtruction will require a very great diameter of the drum, or many turns of a very narrow pipe. In ſuch caſes it will be much better to make the ſpiral in the form of a corkſcrew, as in fig. 17. inſtead of this flat form like a watch-ſpring. The pipe which forms the ſpiral may be lapped round the fruſtum of a cone, whoſe greateſt diameter is to the leaſt (which is next to the riſing-pipe) in the ſame proportion that we aſſigned to CB and CL. By this conſtruction the water will ſtand in every round ſo as to have its upper and lower ſurfaces tangents to the top and bottom of the ſpiral, and the water columns will occupy the whole aſcending ſide of the machine, while the air occupies the deſcending ſide.

Fig. 17.

This form is vaſtly preferable to the flat: it will allow us to employ many turns of a large pipe, and therefore produce a great elevation of a large quantity of water.

The ſame thing will be ſtill better done by lapping the pipe on a cylinder, and making it taper to the end, in ſuch a proportion that the contents of each round may be the ſame as when it is lapped round the cone. It will raiſe the water to a greater height (but with an increaſe of the impelling power) by the ſame number of turns, becauſe the vertical or preſſing height of each column is greater.

Nay, the ſame thing may be done in a more ſimple manner, by lapping a pipe of uniform bore round a cylinder. But this will require more turns, becauſe the water columns will have leſs differences between the heights of their two ends. It requires a very minute inveſtigation to ſhow the progreſs of the columns of air and water in this conſtruction, and the various changes of their arrangement, before one is attained which will continue during the working of the machine.

We have choſen for the deſcription of the machine that conſtruction which made its principle and manner of working moſt evident, namely, which contained the ſame material quantity of air in each turn of the ſpiral, more and more compreſſed as it approaches to the riſing-pipe. We ſhould otherwiſe have been obliged to inveſtigate in great detail the gradual progreſs of the water, and the frequent changes of its arrangement, before we could ſee that one arrangement would be produced which would remain conſtant during the working of the machine. But this is not the beſt conſtruction. We ſee that, in order to raiſe water to the height of a column of 34 feet, which balances the atmoſphere, the air in the laſt ſpire is compreſſed into half its bulk; and the quantity of water delivered into the main at each turn is but half of what was received into the firſt ſpire, the reſt flowing back from ſpire to ſpire, and being diſcharged at the ſpout.

But it may be conſtructed ſo as that the quantity of water in each ſpire may be the ſame that was received into the firſt; by which means a greater quantity (double in the inſtance now given) will be delivered into the main, and raiſed to the ſame height by very nearly the ſame force.—This may be done by another proportion of the capacity of the ſpires, whether by a change of their caliber or of their diameters. Suppoſe the bore to be the ſame, the diameter muſt be made ſuch that the conſtant column of water, and the column of air, compreſſed

preſſed to the proper degree, may occupy the whole circumference. Let A be the column of water which balances the atmoſphere, and h the height to which the water is to be raiſed. Let A be to A+h as 1 to m.

It is plain that m will repreſent the denſity of the air in the laſt ſpire, if its natural denſity be 1, becauſe it is preſſed by the column A+h, while the common air is preſſed by A. Let 1 repreſent the conſtant water column, and therefore nearly equal to the air column in the firſt ſpire. The whole circumference of the laſt ſpire muſt be $1+\frac{1}{m}$, in order to hold the water 1, and the air compreſſed into the ſpace $\frac{1}{m}$ or $\frac{A}{A+h}$.

The circumference of the firſt ſpire is 1+1 or 2. Let D and d be the diameters of the firſt and laſt ſpires; we have $2 : 1+\frac{1}{m} = D : d$, or $2m : m+1 = D : d$. Therefore if a pipe of uniform bore be lapped round a cone, of which D and d are the end diameters, the ſpirals will be very nearly ſuch as will anſwer the purpoſe. It will not be quite exact, for the intermediate ſpirals will be ſomewhat too large. The conoidal fruſtum ſhould be formed by the revolution of a curve of the logarithmic kind. But the error is very trifling.

With ſuch a ſpiral, the full quantity of water which was confined in the firſt ſpiral will find room in the laſt, and will be ſent into the main at every turn. This is a very great advantage, eſpecially when the water is to be much raiſed. The ſaving of power by this change of conſtruction is always in proportion of the greateſt compreſſion of the air.

The great difficulty in the conſtruction of any of theſe forms is in determining the form and poſition of the horn and the ſcoop; and on this greatly depends the performance of the machine. The following inſtructions will make it pretty eaſy.

Fig. 18. Let ABEO (fig. 18.) repreſent the firſt or outermoſt round of the ſpiral, of which the axis is C. Suppoſe it immerged up to the axis in the water VV′, we have ſeen that the machine is moſt effective when the ſurfaces KB and On of the water columns are diſtant the whole diameter BO of the ſpiral. Therefore let the pipe be firſt ſuppoſed of equal caliber to the very mouth Ee, which we ſuppoſe to be juſt about to dip into the water. The ſurface On is kept there, in oppoſition to the preſſure of the water column BAO, by the compreſſed air contained in the quadrant OE, and in the quadrant which lies behind EB. And this compreſſion is ſupported by the columns behind, between this ſpire and the riſing pipe. But the air in the outermoſt quadrant EB is in its natural ſtate, communicating as yet with the external air. When, however, the mouth Ee has come round to A, it will not have the water ſtanding in it in the ſame manner, leaving the half ſpace BEO filled with compreſſed air; for it took in and confined only what filled the quadrant BE. It is plain, therefore, that the quadrant BE muſt be ſo ſhaped as to take in and confine a much greater quantity of air; ſo that when it has come to A, the ſpace BEO may contain air ſufficiently denſe to ſupport the column AO. But this is not enough: For when the wide mouth, now at Aa, riſes up to the top, the ſurface of the water in it riſes alſo, becauſe the part AOoa is more capacious than the cylindric part OEeo which ſucceeds it, and which cannot contain all the water that it does. Since, then, the water in the ſpire riſes above A, it will preſs the water back from On to ſome other poſition m' n', and the preſſing height of the water column will be diminiſhed by this riſing on the other ſide of O. In ſhort, the horn muſt begin to widen, not from B, but from A, and muſt occupy the whole ſemicircle ABE; and its capacity muſt be to the capacity of the oppoſite cylindrical ſide as the ſum of BO, and the height of a column of water which balances the atmoſphere to the height of that column. For then the air which filled it, when of the common denſity, will fill the uniform ſide BEO, when compreſſed ſo as to balance the vertical column BO. But even this is not enough; for it has not taken in enough of water. When it dipped into the ciſtern at E, it carried air down with it, and the preſſure of the water in the ciſtern cauſed the water to riſe into it a little way; and ſome water muſt have come over at B from the other ſide, which was drawing narrower. Therefore when the horn is in the poſition EOA, it is not full of water. Therefore when it comes into the ſituation OAB, it cannot be full nor balance the air on the oppoſite ſide. Some will therefore come out at O, and riſe up through the water. The horn muſt therefore, 1ſt, Extend at leaſt from O to B, or occupy half the circumference; and, 2dly, It muſt contain at leaſt twice as much water as would fill the ſide BEO. It will do little harm though it be much larger; becauſe the ſurplus of air which it takes in at E will be diſcharged, as the end Ee of the horn riſes from O to B, and it will leave the preciſe quantity that is wanted. The overplus water will be diſcharged as the horn comes round to dip again into the ciſtern. It is poſſible, but requires a diſcuſſion too intricate for this place, to make it of ſuch a ſize and ſhape, that while the mouth moves from E to B, paſſing through O and A, the ſurface of the water in it ſhall advance from Ee to On, and be exactly at O when the beginning or narrow end of the horn arrives there.

We muſt alſo ſecure the proper quantity of water. When the machine is ſo much immerſed as to be up to the axis in water, the capacity which thus ſecures the proper quantity of air will alſo take in the proper quantity of water. But it may be erected ſo as that the ſpirals ſhall not even reach the water. In this caſe it will anſwer our purpoſe if we join to the end of the horn a ſcoop or ſhovel QRSB (fig. 19.), which is ſo formed as to take in at leaſt as much water as will fill the horn. This is all that is wanted in the beginning of the motion along the ſpiral, and more than is neceſſary when the water has advanced to the ſucceeding ſpire; but the overplus is diſcharged in the way we have mentioned. At the ſame time, it is needleſs to load the machine with more water than is neceſſary, merely to throw it out again. We think that if the horn occupies fully more than one-half of the circumference, and contains as much as will fill the whole round, and if the ſcoop lifts as much as will certainly fill the horn, it will do very well. Fig. 19.

N. B. The ſcoop muſt be very open on the ſide next the axis, that it may not confine the air as ſoon as it enters the water. This would hinder it from receiving water enough.

The

WATER WORKS.

Fig. 1.

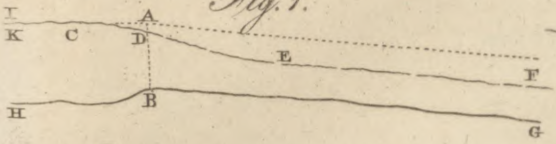


Fig. 2.

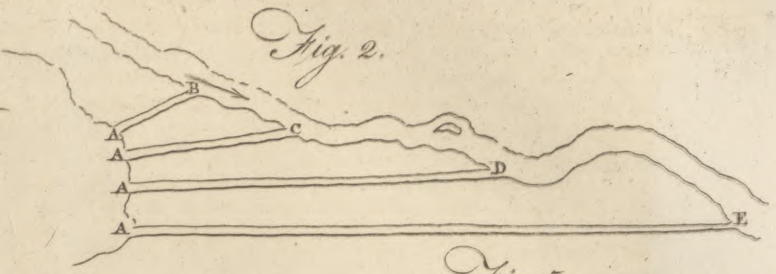


Fig. 3.

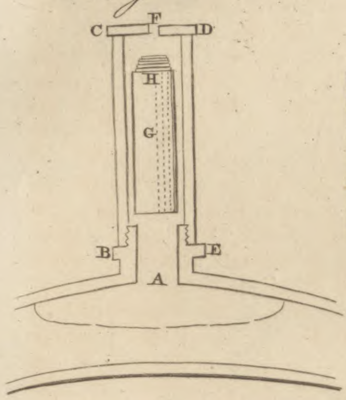
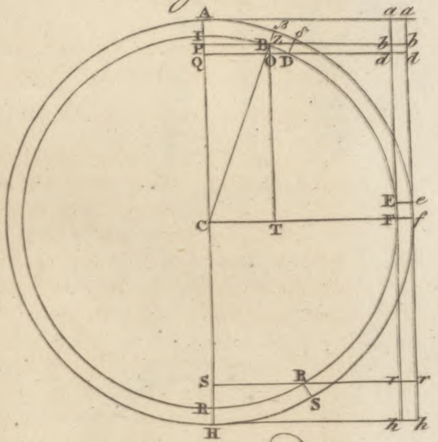


Fig. 4.

Fig. 5.



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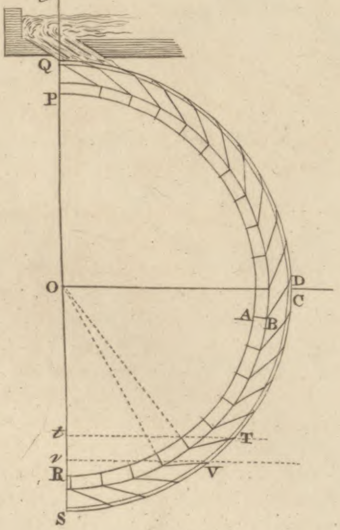


Fig. 7.

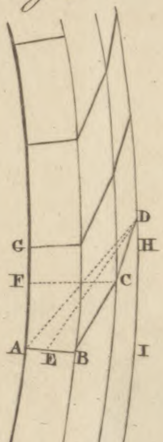


Fig. 8.

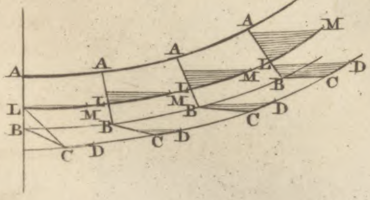


Fig. 9.

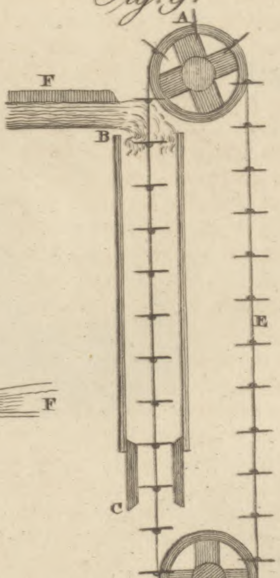


Fig. 10.

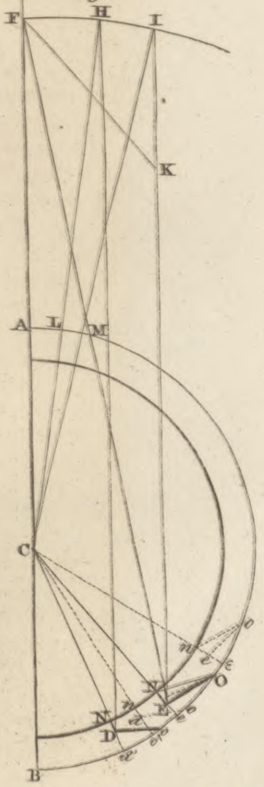
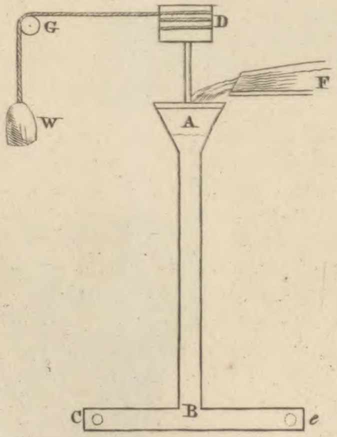


Fig. 11.



W. Train Sculp^t

WATER WORKS. Plate DLXXIV.

Fig. 12.

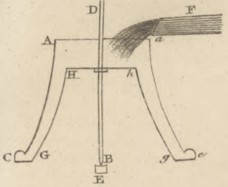


Fig. 13.

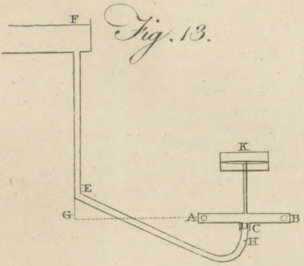


Fig. 14.

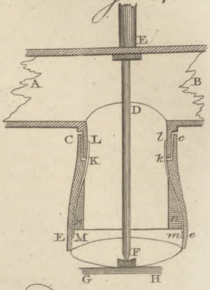


Fig. 15.

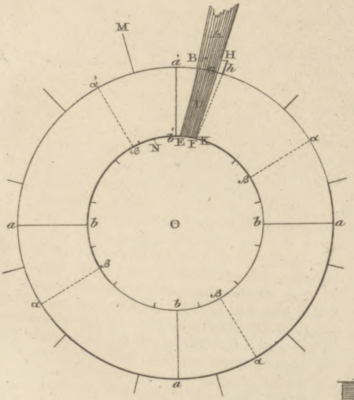


Fig. 16.

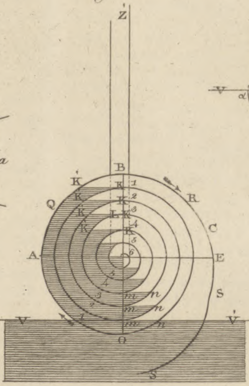


Fig. 18.

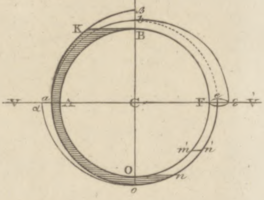


Fig. 20.

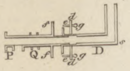


Fig. 17.

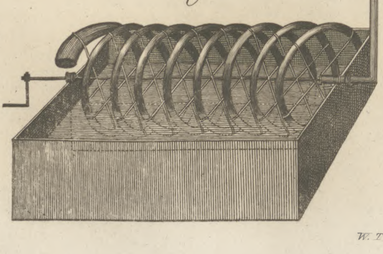
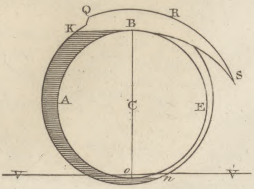


Fig. 19.



W. Train Sculpt.

The following dimenſions of a machine erected at Florence, and whoſe performance correſponded extremely well with the theory, may ſerve as an example.

The ſpiral is formed on a cylinder of 10 feet diameter, and the diameter of the pipe is 6 inches. The ſmaller end of the horn is of the ſame diameter; and it occupies three-fourths of the circumference, and it is $7\frac{8}{10}$ths inches wide at the outer end. Here it joins the ſcoop, which lifts as much water as fills the horn, which contains 4340 Swediſh cubic inches, each = 1.577 Engliſh. The machine makes ſix turns in a minute, and raiſes 1354 pounds of water, or 22 cubic feet, 10 feet high in a minute.

The above account will, we hope, ſufficiently explain the manner in which this ſingular hydraulic machine produces its effect. When every thing is executed by the maxims which we have deduced from its principles, we are confident that its performance will correſpond to the theory; and we have the Florentine machine as a proof of this. It raiſes more than $\frac{10}{11}$ths of what the theory promiſes, and it is not perfect. The ſpiral is of equal caliber, and is formed on a cylinder. The friction is ſo inconſiderable in this machine, that it need not be mended: but the great excellency is, that whatever imperfection there may be in the arrangement of the air and water columns, this only affects the elegance of the execution, cauſing the water to make a few more turns in the ſpiral before it can mount to the height required; but waſtes no power, becauſe the power employed is always in proportion to the ſum of the vertical columns of water in the riſing ſide of the machine; and the height to which the water is raiſed by it is in the very ſame proportion. It ſhould be made to move very ſlow, that the water be not always dragged up by the pipes, which would cauſe more to run over from each column, and diminiſh the preſſure of the remainder.

If the riſing-pipe be made wide, and thus room be made for the air to eſcape freely up through the water, it will riſe to the height aſſigned; but if it be narrow, ſo that the air cannot get up, it riſes almoſt as ſlow as the water, and by this circumſtance the water is raiſed to a much greater height mixed with air, and this with hardly any more power. It is in this way that we can account for the great performance of the Florentine machine, which is almoſt triple of what a man can do with the fineſt pump that ever was made: indeed the performance is ſo great, that one is apt to ſuſpect ſome inaccuracy in the accounts. The entry into the riſing-pipe ſhould be no wider than the laſt part of the ſpiral; and it would be adviſable to divide it into four channels by a thin partition, and then to make the riſing-pipe very wide, and to put into it a number of ſlender rods, which would divide it into ſlender channels that would completely entangle the air among the water. This will greatly increaſe the height of the heterogeneous column. It is ſurpriſing that a machine that is ſo very promiſing ſhould have attracted ſo little notice. We do not know of any being erected out of Switzerland except at Florence in 1778. The account of its performance was in conſequence of a very public trial in 1779, and honourable declaration of its merit, by Sig. Lorenzo Ginori, who erected another, which fully equalled it. It is ſhortly mentioned by Profeſſor Sulzer of Berlin, in the *Sammlungen Vermiſcklen Schriften* for 1754. A deſcription of it is publiſhed by the Philoſophical Society at Zurich in 1766, and in the deſcriptions publiſhed by the Society in London for the encouragement of Arts in 1776. The celebrated Daniel Bernoulli has publiſhed a very accurate theory of it in the Peterſburgh Commentaries for 1772, and the machines at Florence were erected according to his inſtructions. Baron Alſtromer in Sweden cauſed a glaſs model of it to be made, to exhibit the internal motions for the inſtruction of artiſts, and alſo ordered an operative engine to be erected; but we have not ſeen any account of its performance. It is a very intricate machine in its principles; and an ignorant engineer, nay the moſt intelligent, may erect one which ſhall hardly do any thing; and yet, by a very trifling change, may become very powerful. We preſume that failures of this kind have turned the attention of engineers from it; but we are perſuaded that it may be made very effective, and we are certain that it muſt be very durable. Fig. 20. is a ſection of the manner in which the author has formed the communication between the ſpiral and the riſing-pipe. P is the end of the hollow axis which is united with the ſolid iron axis. Adjoining to P, on the under ſide, is the entry from the laſt turn of the ſpiral. At Q is the collar which reſts on the ſupports, and turns round in a hole of bell-metal. *f f* is a broad flanch caſt in one piece with the hollow part. Beyond this the pipe is turned ſomewhat ſmaller, very round and ſmooth, ſo as to fit into the mouth of the riſing-pipe, like the key of a cock. This mouth has a plate *e e* attached to it. There is another plate *d d*, which is broader than *e e*, and is not fixed to the cylindrical part, but moves eaſily round it. In this plate are four ſcrews, ſuch as *g*, *g*, which go into holes in the plate *f f*, and thus draw the two plates *f f* and *d d* together, with the plate *e e* between them. Pieces of thin leather are put on each ſide of *e e;* and thus all eſcape of water is effectually prevented, with a very moderate compreſſion and friction.

Fig. 20.

WATERFORD, a city and ſea-port of Ireland, in a county of the ſame name, with a biſhop's ſee. It is the ſecond place in the kingdom, and is a wealthy, populous city, enjoying many ample privileges. The ſtreets are narrow, and the air is not very healthy; but it has an excellent harbour, ſeated as well for trade as any in the world, and ſhips of the greateſt burden may ride at the quay. It ſtands on the river Sure, 8 miles north of St George's Channel, 26 ſouth of Kilkenny, and 75 ſouth by weſt of Dublin. W. Long. 6. 54. N. Lat. 52. 18.

WATERFORD, a county of Ireland, 46 miles in length, and 25 in breadth; bounded on the ſouth by St George's Channel; on the weſt by Cork; on the north by the river Sure, which ſeparates it from Tipperary and Kilkenny; and on the eaſt by Waterford Haven, which parts it from Wexford. It contains 71 pariſhes, and ſends 10 members to parliament. It is a fine country, very pleaſant and rich, and the principal place is of the ſame name.

WATERING, in the manufactures, is to give a luſtre to ſtuffs, &c. by wetting them lightly with gum-water, and then paſſing them through the preſs or calender whether hot or cold. The gum-water ought to be pure, thin, and clear, otherwiſe the folds of the ſtuff will all ſtick together: the operation muſt alſo be performed when the water is very hot, that it may penetrate.

WATERING Meadows. See MEADOWS.

WATERLAND, DR DANIEL, a learned Engliſh divine who diſtinguiſhed himſelf greatly in theological controverſies, was born in 1683 at Waſely in Lincolnſhire, of which place his father was rector. He had his academical learning at Magdalen college, Cambridge, where he drew up a uſeful tract, which went through ſeveral editions, intitled, *Advice to a Young Student, with a Method of Study for the firſt four years.* In 1713 he became maſter of the the college, was ſoon after appointed chaplain to George I. and in 1720 preached the firſt courſe of lectures founded by Lady Moyer in defence of our Lord's divinity. He went through ſeveral promotions; and at the time of his death in 1740, was canon of Windſor, archdeacon of Middleſex, and vicar of Twickenham. Beſides his controverſial writings, he publiſhed two volumes of ſermons.

WATLING-STREET. See WAY.

WATSON, DR ROBERT, an elegant hiſtorian, was born at St Andrew's in Scotland, about the year 1730. He was the ſon of an apothecary of that place, who was alſo a brewer. Having gone through the uſual courſe of languages and philoſophy at the ſchool and univerſity of his native place, and alſo entered on the ſtudy of divinity, a deſire of being acquainted with a larger circle of literati, and of improving himſelf in every branch of knowledge, carried him, firſt to the univerſity of Glaſgow, and afterwards to that of Edinburgh. The period of theological ſtudies at the univerſities of Scotland is four years: but during that period, young men of ingenious minds find ſufficient leiſure to carry on and advance the purſuits of general knowledge. Mr Watſon purſued his ſtudies with ardour. Few men ever ſtudied more conſtantly. It was a rule with him to ſtudy eight hours every day; and this law he obſerved during the whole courſe of his life. An acquaintance with the polite writers of England, after the union of the two kingdoms, became general in Scotland; and in Watſon's younger years, an emulation began to prevail of writing pure and elegant Engliſh. Mr Watſon applied himſelf with great induſtry to the principles of philoſophical or univerſal grammar; and by a combination of theſe, with the authority of the beſt Engliſh writers, formed a courſe of lectures on ſtyle or language. He proceeded to the ſtudy of rhetoric or eloquence; the principles of which he endeavoured to trace to the nature of the human mind. He delivered a courſe of lectures in Edinburgh on theſe ſubjects; and met with the countenance, approbation, and friendſhip of Lord Kames, Mr Hume, with other men of genius and learning.

At this time he had become a preacher; and a vacancy having happened in one of the churches of St Andrew's, he offered himſelf a candidate for that living, but was diſappointed. Soon after he was appointed profeſſor of logic; and he obtained alſo a patent from the crown, conſtituting him profeſſor of rhetoric and belles lettres. The ſtudy of logic, in St Andrews, as in moſt other places, was at this time confined to ſyllogiſms, modes, and figures. Mr Watſon, whoſe mind had been opened by converſation, and by reading the writings of the wits that had begun to flouriſh in the Scotch capital, prepared and read to his ſtudents a courſe of metaphyſics and logics on the moſt enlightened plan; in which he analyzed the powers of the mind, and entered deeply into the nature of the different ſpecies of evidence of truth or knowledge. By his hiſtory of Philip II. Dr Watſon attained in his lifetime a conſiderable degree of celebrity; and his hiſtory of Philip III. publiſhed after his death, has added to his fame. Of this laſt performance, however, he has only completed the firſt four books; the two laſt were written by the editor of his manuſcript, at the deſire of the guardians of his children.

On the death of Principal Tulideph, Dr Watſon, through the earl of Kinnoull, was appointed his ſucceſſor; in which ſtation he lived only a few years. He married a lady of ſingular beauty and virtue, daughter to Mr Shaw, profeſſor of divinity in St Mary's college, St Andrew's. By this lady he had five daughters, who ſurvived him.

WATTS, DR ISAAC, a learned and eminent diſſenting miniſter, was born at Southampton in 1674, of parents eminent for piety, and conſiderable ſufferers for conſcience-ſake. In 1690 he was ſent up to London for academical education under the tuition of the Rev. Mr Thomas Rowe; and in 1696 was himſelf engaged as tutor to the ſon of Sir John Hartopp, Bart. at Stoke Newington. He began to preach in 1698, and met with general acceptance; and after officiating as an aſſiſtant to the Rev. Dr Iſaac Chauncy, he ſucceeded in his paſtoral charge in 1702, and continued to preſide over that church as long as he lived. Though his whole income did not amount to an hundred a-year, he allotted one third of it to the poor. He died in 1748. His numerous works have rendered his name famous among people of every denomination, both in this and other countries, and have been tranſlated into a variety of languages. His Lyric Poems, his Pſalms and Hymns, and his Divine Songs for Children, are a ſufficient proof of his poetical talents, and have had an amazing number of editions. His logic and philoſophy have been much admired. He alſo wrote works upon a variety of other ſubjects, and printed ſeveral volumes of his ſermons. He was admired for the mildneſs and benevolence of his diſpoſition and the ſweetneſs of his manners. After his death, his works were collected, and publiſhed in ſix volumes quarto.

WAVE, in *Philoſophy*, a cavity in the ſurface of water, or other fluids, with an elevation aſide thereof.

The waves of the ſea are of two kinds, natural and accidental. The natural waves are thoſe which are exactly proportioned in ſize to the ſtrength of the wind, whoſe blowing gives origin to them. The accidental waves are thoſe occaſioned by the wind's reacting upon itſelf by repercuſſion from hills and mountains, or high ſhores, and by the waſhing of the waves themſelves, otherwiſe of the natural kind, againſt rocks and ſhoals: all theſe cauſes give the waves an elevation, which they can never have in their natural ſtate. For the height of the waves, ſee SEA.

Stilling WAVES *by means of Oil.* See SEA.

WAVED, in *Heraldry*, is ſaid of a bordure, or any ordinary or charge, in a coat of arms, having its outlines indented in manner of the riſing and falling of waves: it is uſed to denote, that the firſt of the family in whoſe arms it ſtands, acquired its honours by ſea-ſervice.

WAVING, in the ſea-language, is the making ſigns to a veſſel to come near or keep off.

WAX, or *Bees* WAX, in *Natural Hiſtory*, a firm and ſolid ſubſtance, moderately heavy, and of a fine yellow colour, formed by the bees from the pollen of flowers. See APIS.

The beſt ſort is that of a lively yellow colour, and an agreeable ſmell, ſomewhat like that of honey: when new, it is toughiſh, yet eaſy to break; but by age it becomes harder and more brittle, loſes its fine colour, and in a great meaſure its ſmell.

It appears that wax and the pollen have for their baſis a fat oil, which paſſes to the ſtate of reſin by its combination with oxygen. If the nitric or muriatic acid be digeſted upon fixed oil for ſeveral months, it paſſes to a ſtate reſembling wax. Wax, by repeated diſtillations, affords an oil which poſſeſſes all the properties of volatile oils. It is reduced into water and carbonic acid by combuſtion. The colouring matter of wax is inſoluble in water and in alcohol.

Fixed alkalies diſſolve wax, and render it ſoluble in water. It is this ſaponaceous ſolution which forms the punic wax. It may be uſed as the baſis of ſeveral colours; and may be made into an excellent paſte for waſhing the hands. Ammoniac likewiſe diſſolves it; and as this ſolvent is evaporable, it ought to be preferred when it is propoſed to uſe the wax as a varniſh.

From the common yellow wax, by bleaching, is formed white-wax, ſometimes called, very improperly, *virgin-wax.* The greater the ſurface is in proportion to the quantity, the ſooner and more perfectly this operation is performed. The uſual way is to melt the wax in hot water; when melted, they preſs it through a ſtrainer of tolerable fine linen, and pour it into round and very ſhallow moulds. When hardened by cooling, it is taken out and expoſed to the ſun and air, ſprinkling it now and then with water, and often turning it: by this means it ſoon becomes white. The beſt ſort is of a clear and almoſt tranſparent whiteneſs, dry, hard, brittle, and of an agreeable ſmell, like that of the yellow wax, but much weaker.

The common yellow wax is of very great uſe both in medicine and in many of the arts and manufactures. It has been ſometimes given internally in dyſenteries and eroſions of the inteſtines; but its great uſe is in the making ointments and plaſters, and the greater part of thoſe of the ſhops owe their conſiſtence to it. The white wax is alſo an ingredient in ſome of the cerates and ointments of the ſhops; and is uſed in making candles, and in many of the nicer arts and manufactures where wax is required.

Sealing-WAX, or *Spaniſh-WAX*, is a compoſition of gum lac, melted and prepared with reſins, and coloured with ſome ſuitable pigment.

There are two kinds of ſealing-wax in uſe; the one hard, intended for ſealing letters, and other ſuch purpoſes; the other ſoft, deſigned for receiving the impreſſions of ſeals of office to charters, patents, and ſuch written inſtruments. The beſt hard red ſealing-wax is made by mixing two parts of ſhell lac, well powdered, and reſin and vermilion, powdered, of each one part, and melting this combined powder over a gentle fire; and when the ingredients ſeem thoroughly incorporated, working the wax into ſticks. Seed-lac may be ſubſtituted for the ſhell-lac; and inſtead of reſin, boiled Venice turpentine may be uſed. A coarſer, hard, red ſealing-wax, may be made, by mixing two parts of reſin, and of ſhell-lac, or vermilion and red lead, mixed in the proportion of one part of the vermilion to two of the red lead, of each one part; and proceeding as in the former preparation. For a cheaper kind, the vermilion may be omitted, and the ſhell-lac alſo, for very coarſe uſes. Wax of other colours is made by ſubſtituting other colouring matters for vermilion, as verditer for blue, ivory black for black wax. For uncoloured, ſoft ſealing-wax, take of bees wax, one pound; of turpentine, three ounces; and of olive oil, one ounce; place them in a proper veſſel over the fire, and let them boil for ſome time; and the wax will be then fit to be formed into rolls or cakes for uſe. For red, black, green, blue, yellow, and purple ſoft ſealing-wax, add to the preceding compoſition an ounce or more of any ingredients directed above for colouring the hard ſealing-wax, and ſtir the maſs till the colouring ingredients be incorporated with the wax.

WAX-Work, the repreſentation of the faces, &c. of perſons living or dead; made by applying plaſter of Paris in a kind of paſte, and thus forming a mould containing the exact repreſentation of the features. Into this mould melted wax is poured, and thus a kind of maſks are formed; which being painted and ſet with glaſs eyes, and the figures dreſſed in their proper habits, they bear ſuch a reſemblance that it is difficult to diſtinguiſh between the copy and the original.

WAY, a paſſage or road.

The Roman ways are divided into conſular, prætorian, military, and public; and of theſe we have four remarkable ones in England: the firſt, Watling-ſtreet, or Watheling-ſtreet, leading from Dover to London, Dunſtable, Toweeſter, Atterſton, and the Severn, extending as far as Angleſea in Wales. The ſecond, called *Hikenild* or *Ikenild ſtreet*, ſtretches from Southampton over the river Iſis at Newbridge; thence by Camden and Litchfield; then paſſes the Derwent near Derby, and ends at Tinmouth. The third, called *Foſſe-way*, becauſe in ſome places it was never perfected, but lies as a large ditch, leads from Cornwall through Devonſhire, by Tethbury, near Stow in the Wolds; and beſide Coventry to Leiceſter, Newark, and ſo to Lincoln. The fourth, called *Erming* or *Erminage ſtreet*, extends from St David's, in Wales, to Southampton.

WAY Covert, Gang, Hatch. See *COVERT Way*, *GANG*, &c.

WAY of a Ship, is ſometimes the ſame as her rake, or run forward or backward: but this term is moſt commonly underſtood of her ſailing.

WAY-Leaves, in the coal buſineſs. See COALERY, N° 3.

Right of WAYS, in *Law*. This may be grounded on a ſpecial permiſſion; as when the owner of the land grants to another a liberty of paſſing over his grounds, to go to church, to market, or the like: in which caſe the gift or grant is particular, and confined to the grantee alone; it dies with the perſon; and if the grantee leaves the country, he cannot aſſign over his right to any other; nor can he juſtify taking another perſon in his company. A way may be alſo by preſcription; as if all the owners and occupiers of ſuch a farm have immemorially uſed to croſs another's ground; for this immemorial uſage ſuppoſes an original grant, whereby a right of way thus appurtenant to land may clearly be created. A right of way may alſo ariſe by act and operation of law; for if a man grants me a piece of ground in the middle of his field, he at the ſame time tacitly and impliedly gives me a way to come at it; and I may croſs his land for that purpoſe without treſpaſs. For when the law doth give any thing to one, it giveth impliedly whatſoever is neceſſary for enjoying the ſame. By the law of the twelve tables at Rome, where a man had the right of way over another's land, and the road was out of repair, he who had the right of way might go over any part of the land he pleaſed; which was the eſtabliſhed rule in public as well as private ways. And the law of England, in both caſes, ſeems to correſpond with the Roman.

WAYFARING TREE. See VIBURNUM, BOTANY *Index.*

WAYGHTES, or WAITS, a word which is uſed only in the plural number, and ſignifies *hautboys*. It is now applied to the performers on theſe and other muſical inſtruments, by a tranſition from the inſtruments themſelves, and particularly to thoſe performers who parade the ſtreets by night, about the Chriſtmas ſeaſon of the year.

WAYWODE, is properly a title given the governors of the chief places in the dominions of the czar of Muſcovy. The palatines, or governors of provinces in Poland, alſo bear the quality of *waywodes* or *waiwodes*. The Poles likewiſe call the princes of Wallachia and Moldavia *waywodes;* as eſteeming them no other than on the foot of governors; pretending that Wallachia and Moldavia are provinces of Poland. Everywhere elſe theſe are called *hoſpodars*. Du Cange ſays, that the name *waywode* is uſed in Dalmatia, Croatia, and Hungary, for a general of an army: and Leunclavius, in his Pandects of Turkey, tells us, it uſually ſignifies *captain* or *commander*.

WEANING, putting a child away from the breaſt, and bringing it to uſe common food.

WEAR, or WEER, a great ſtank or dam in a river, fitted for the taking of fiſh, or for conveying the ſtream to a mill. New wears are not to be made, or others altered, to the nuiſance of the public, under a certain penalty. See RIVER.

WEARING, or VEERING, in *Seamanſhip*. See SEAMANSHIP.

WEASEL. See MUSTELA, MAMMALIA *Index.*

WEATHER denotes the ſtate of the atmoſphere with regard to heat and cold, wind, rain, and other meteors. See METEOROLOGY.

WEATHER, in ſea-language, is uſed as an adjective, and applied by mariners to every thing lying to windward of a particular ſituation: thus, a ſhip is ſaid to have the weather-gage of another, when ſhe is farther to windward. Thus alſo, when a ſhip under ſail preſents either of her ſides to the wind, it is then called the *weather-ſide* or *weather-board;* and all the rigging and furniture ſituated thereon are diſtinguiſhed by the ſame epithet, as the *weather-ſhrouds*, the *weather-lifts*, the *weather-braces*, &c.

To WEATHER, in ſea-language, is to ſail to windward of ſome ſhip, bank, or head-land.

WEATHER-Cock, a moveable vane, in form of a cock, or other ſhape, placed on high, to be turned round according to the direction of the wind, and point out the quarter from whence it blows.

WEATHER Glaſs. See BAROMETER.

WEATHERING, among ſailors, ſignifies the doubling or ſailing by a head-land or other place.

WEAVING, the art of working a web of cloth, ſilk, or other ſtuff, in a loom with a ſhuttle. For an idea of the manner in which this is performed, ſee CLOTH.

WEAVING-Loom, a machine for weaving cloth, ſilk, &c. by raiſing the threads of the warp in order to throw in the ſhoot, and ſtrike it cloſe. Of theſe there are various kinds, diſtinguiſhed by the different ſorts of cloths, ſtuffs, ſilks, &c. in which they are employed, and which are chiefly diſtinguiſhed by the number and variety of the threads they raiſe in order to work the warp, either plain or in figures, by making more or leſs of the woof or ſhoot appear through the warp. In order to give a general idea of weaving, we ſhall here deſcribe the parts of the common weaver's loom. Fig. 1. in which *e f*, *e f* are the front poſts, and *g*, *g* the back poſts of the loom; *l l*, *m m*, *m m* are the *lams* in their place at Q, or, as they are called in ſome parts of Scotland, the *headles*, and in others the *ſlaves*. They are compoſed of ſtrong threads, ſtretched between two horizontal bars, an upper and a lower. The threads of one lam are ſo diſpoſed as to paſs between the upper threads of the warp, while they admit the lower threads to paſs through loops or ſmall holes in them, and the diſpoſition of the threads of the other lam is ſuch, that while they paſs between the lower threads of the warp, they admit the upper threads to paſs through the ſmall holes juſt mentioned. The lams are ſuſpended from the croſs bar or *lam-bearer* HH, by means of ropes *n*, *n* paſſing from the upper bars of the *lams* over the pulleys at EE, and balanced by weights at the other ends. From the lower bar of each *lam* or *headle* a rope paſſes to the *treadles* or moveable bars at OO; ſo that when a foot preſſes a treadle, the lam faſtened to it ſinks, while the other riſes by means of the balancing weight ſuſpended from the pulley at E. The workman then throws in the woof by means of the ſhuttle, and cloſes it by one or two ſtrokes of the *lay* or *batten*, of which WB, WB are called the *ſwords*, CC the *cap*, or in Scotland the upper *ſhell*, DD the *block* or under *ſhell*, and PP the *reed* or *comb* contained between theſe ſhells. LL is the bench on which the workmen ſit; for the loom which our figure repreſents is conſtructed for weaving cloth of ſuch a breadth as to require two workmen, who have their quills in a box *d* on the middle of the bench on which they ſit. Between the workmen's bench and the *batten* or *lay* is the *breaſt-bar* I, I, a ſmooth ſquare beam, in which there is an opening to let the web through as it is wove. From this opening the web SS paſſes to the *knee roll* or *web beam* GG, round which it is rolled by means of the ſpokes, viſible in the figure, and kept from being unrolled by a wheel with teeth and clench, viſible likewiſe in the figure. In ſome looms the web paſſes from the knee roll to the wooden frame X, to be dried as it is wove. Oppoſite to the breaſt-bar, and on the other ſide of the *batten* or *lay*, is the *cane-roll* or *yarn-beam*, on which the warp is rolled when put into the loom, and from which it is gradually unrolled as the work proceeds. TT are bobbins filled with yarn of the warp to mend ſuch threads of it as may be broke in the weaving; and B *b*, B *b* are clues of the ſame kind of yarn with the borders of the warp, to mend ſuch threads as may there be broken.

Plate DLXXV. Fig. 1.

Fig. 2.

Fig. 2. repreſents the common ſhuttle with the vacuity in the middle, in which the quill with the woof is placed on a ſpindle or axis. As this ſhuttle is thrown with one hand in at one ſide of the warp, and received

Fig. 3.

Fig. 4.

with the other hand at the other ſide, it is obvious, that when the web is of a breadth too great for a man to reach from one ſide of it to the other, two workmen muſt be employed and much time loſt. To remedy this inconveniency, a new ſhuttle has, in this country, been lately brought into very general uſe, and called the *flying ſhuttle*, becauſe it flies through the warp with wonderful rapidity on two ſteel rollers RR (fig. 3.) This ſhuttle is not thrown with the hand, but moved backwards and forwards by a very ſimple piece of machinery, of which fig. 4. will give the reader a ſufficiently accurate conception. To each end of the *batten* or *lay* L is faſtened a kind of open box B, *b*, with the bottom or horizontal ſide exactly on a level with the threads of the warp of the intended web. In each of theſe boxes is a vertical piece of wood D, *d*, of conſiderable thickneſs, called a *driver*. This driver is moved eaſily on an iron ſpindle or axis from one end of the box to the other by means of a ſlender rope CCCD, and a handle H is ſeen in the figure. When the weaver is to begin his work, he lays the ſhuttle on its rollers in the box B with the iron tip T (fig. 3.) touching, or almoſt touching, the driver D (fig. 4.). Then moving the handle H, with a ſudden jerk, towards the box *b*, the driver D forces the ſhuttle with a rapid motion through the warp till it ſtrikes *d*, which is impelled by the ſtroke to the further end of the box *b*. The two drivers D and *d* have now changed their poſitions in their reſpective boxes; ſo that the driver which was at the front of its box before, is now at the further end of it, and *vice verſa*. Then by a ſudden jerk of the hand towards B the ſhuttle is driven back till it ſtrike D; and thus is the work continued without the weaver having occaſion ever to ſtretch his arms from one margin of the web to the other. That the ſhuttle may not, by the unſteadineſs of the workman's hand, be driven *zig-zag* through the warp or out of the place in which it ought to move, the guiding or driving rope CCCD is made to paſs through ſmooth holes or loops C, C, at the ends of the ropes EC, EC, ſuſpended either from the croſs bar on the top of the loom or from the ſwords of the batten.

This ſhuttle, we ſhould think, a great improvement in every kind of weaving loom, though ſome of the older tradeſmen, with whom we have converſed on the ſubject, contend, that it is valuable only in what they call light work, ſuch as cotton or linen cloth, or when the web, if woollen, is very broad.

But as the labour of weaving is pretty ſevere, Mr Robert Millar, an ingenious calico-printer in the county of Dumbarton, Scotland, wiſhing to leſſen it, invented, ſome years ago, a weaving-loom, which may be wrought by water, ſteam, horſes, or any other power, for which invention he received a patent in 1796. The following is his own deſcription of his patent weaving-loom:

Fig. 5.

Fig. 5. repreſents a ſide view of the loom, AA, BB, CC, DD, being the frame. *a* is an axis (which we ſhall call the ſpindle) acroſs the frame. On this axis is a ſheeve *b*, two inches thick, having a groove round it, two inches deep, and half an inch wide. The bottom of this groove is circular, except in one part *c*, where it is filled up to the top; a lever *d* reſts on the bottom of this groove, and is lifted up by it when the elevation *c* comes round to the ſituation repreſented in the figure. By this motion, the lever *d* acts on the ratchet-wheel *e* by the catch *t*, and draws it forward one tooth, each revolution of the ſheeve. This ratchet-wheel is in an iron frame *g g*, which alſo properly carries the two catches *t* and *u*, which are connected with it at *v*. The catch *u* holds the ratchet-wheel in its poſition, while the lever *d* and the catch *t*, are moved by the groove *c* in the ſheeve. On the arbor of the ratchet is a ſmall pinion *h*, working in the wheel *f*; this wheel is fixed on the end of the roller *e* of fig. 7. On the ſide of the ſheeve *b* is fixed a wiper *k*, which lifts the treadle *l*. This treadle turns on its joints in the ſheeve E, which is fixed to the ſide of the frame A and D; it is kept preſſing on the bottom of the groove in the ſheeve by a ſpring *m*, fixed to the frame ſide A, and having a ſlender rod *n* from its extremity, joining it with the treadle at *l*. From the point of the treadle there goes a belt *o*, which paſſes over the pulley *p*, which is ſeen edgewiſe in this figure, and is joined to the top of the fly pin *q*, of fig. 6. At the end of the frame A is the ſhort poſt F; on this reſts the yarn-beam *j*, having a ſheeve *r*, over which paſſes a cord, having a weight *s* ſuſpended to it. The other end of this cord is faſtened to the ſpring *v*; the weight cauſes the yarn-beam to ſtretch the web from the ratchet-wheel *e*, with its catch *u*; and the ſpring *v* allows the rope to ſlide on the ſheeve as the ratchet is drawn round during the working.

Fig. 6.

Fig. 6. is a front view of the loom. *a a* is the ſpindle which carries the ſheeve *b*, and the wipers *d* and *d*, which move the treadles *w*, *w*, of fig. 5. Theſe uſe the treadles of the headles, with which they are connected by cords from the ſhafts of the headles *s*, *s*. From the upper ſhaft there go two leathern belts *f*, *f*, to the roller *y*, furniſhed each with a buckle, for tightening them at pleaſure. The two wipers *c*, *c*, on the ſhaft *a*, which ſerve for taking back the lay, have the two treadles *x*, *x*, in fig. 7. with a belt from each paſſing over the roller *h* 2 of fig. 6. and fixed to the ſword of the lay. From the ſwords of the lay forward is fixed a belt to each end of the roller *i*; from this roller there goes a cord to the ſpring *j*, which ſerves for taking forward the lay which is hinged on the rocking-tree *t*. The ſtar-wheel *b* of fig. 3. and the ſheeve *b* of fig. 1. are fixed to the oppoſite ends of the ſpindle *a* without the frame; and both the wheel and ſheeve have a wiper *k* fixed to them for moving the treadles. In order to drive the ſhuttle, the belts *o*, *o*, go from the points of the treadles, over the pulleys *p*, *p*, to the top of the fly-pin *q*: This turns on a pin joint in a rail *r*, which goes acroſs the loom. From its lower end there go two ſmall cords to the ſhuttle drivers *g*, *g*, which ſlide on the iron rods *n*, *n*. A long iron rod *v* goes acroſs the lay, and is hung on two centres at the ends. In this rod *v* are fixed two ſmall crooked wires *w*, *w*, which are more diſtinctly marked in the little figure *w* above, which repreſents a ſection of the lay. The dot at the lower end of the wire *w*, in this figure, is the ſection of the rod *v*. The ſhuttle paſſes between theſe wires and the lay every ſhot, and lifts them up, cauſing the rod *v* to turn round a little. But if the ſhuttle ſhould not paſs theſe wires, nor lift them, it would be drawn home by the lay, and deſtroy the web. To prevent this, there is fixed on one end of the rod *v* a ſtout crooked wire *z*, having a broad or flat head, which naturally reſts on a plate of iron, marked and fixed to the back of the lay. This plate has a ſlit in

its middle about an inch deep. In this ſlit reſts the rod *a* 2 of fig. 7. on which is a ſhort ſtud, which is caught by the wire *z* when the wire *w* is not lifted back by the paſſing ſhuttle. This will ſtop the lay from coming home, and will ſet off the loom.

Fig. 7.

Fig. 7. is another ſide view of the loom oppoſite to fig. 5. On the ſpindle *a* is the ſtar wheel *b*, on the outſide of the loom-frame, on the arms of which wheel is fixed the wiper *k*, as the ſimilar wiper is fixed to the ſheeves on the other end of the ſpindle. The wipers which drive the ſhuttles are fixed on oppoſite ſquares of the ſpindle, and work alternately. Below the ſtar-wheel is a pinion *c*, which is on a round ſpindle, turned by the water-wheel, by means of a wheel on this ſpindle. In a wheel on this ſpindle are two ſtuds, on which the pinion *c* ſlides off and on, as the loom is ſet off and on by the lever *d*. At the farther end of this lever is the weight *s*, hanging by a cord which paſſes over a pulley *t*, fixed at the outer end of the ſpring-catch on which the lever *d* reſts; and thus the loom is drawn in at the upper end of the lever *d*. But when the ſhuttle does not lift the wire *z*, it catches on the ſtud on the rod *a* 2, which is connected with the ſpring-catch, and the lever *d* flies off with the weight *s*, and the loom ſtops working. On the head of the poſt F is the yarn-beam. The rollers *e* and *f* are cylinders, preſſed together by a ſcrew-lever, and take away the cloth between them at a proper rate. In the roller *f* is a groove for a band for driving the roller *g*, on which the cloth winds itſelf as it is wrought. Wherever ſprings are mentioned to be uſed in the above deſcription, weights may be uſed in their ſtead, and to the ſame effect, and more eſpecially upon the treadle of fig. 5. for driving the ſhuttle.

Fig. 8.

Fig. 8. is a repreſentation of a ribband loom. 1. Is the frame of the loom. 2. The caſtle, containing 48 pulleys. 3. The branches, on which the pulleys turn. 4. The tires, or the riding-cords, which run on the pulleys, and pull up the high-liſſes. 5. The liſt-ſticks, to which the high-liſſes are tied. 6. The high-liſſes, or liſts, are a number of long threads, with platines, or plate-leads at the bottom; and ringlets, or loops, about their middle, through which the cords or croſs-threads of the ground-harneſs ride. 7. The plate-leads, or platines, are flat pieces of lead, of about ſix inches long, and three or four inches broad at the top, but round at the bottom; ſome uſe black ſlates inſtead of them: their uſe is to pull down thoſe liſſes which the workman had raiſed by the treadle, after his foot is taken off. 8. The branches or cords of the ground harneſs, which go through the loops in the middle of the high-liſſes: on the well ordering of theſe cords chiefly depends the art of ribbon-weaving, becauſe it is by means of this contrivance that the weaver draws in the thread or ſilk that makes the flower, and rejects or excludes the reſt. 9. The batton: this is the wooden frame that holds the reed or ſhuttle, and beats or cloſes the work: where, obſerve, that the ribbon-weaver does not beat his work; but as ſoon as the ſhuttle is paſſed, and his hand is taken away, the batton is forced, by a ſpring from the top, to beat the work cloſe. 10. The ſhuttle, or reed. 11. The ſpring of the batton, by which it is made to cloſe the work. 12. The long-harneſs are the front-reeds, by which the figure is raiſed. 13. The linguas are the long pieces of round or ſquare lead, tied to the end of each thread of the long-harneſs to keep them tight. 14. The broad piece of wood, about a foot ſquare, leaning ſomewhat forward, intended to eaſe the weaver as he ſtoops to his ſhuttle; it is fixed in the middle of the breaſt-beam. Some weavers, inſtead of this, have a contrivance of a cord or rope that is faſtened to the front-frame, and comes acroſs his breaſt; this is called a *ſtopfall*. 15. The ſeat-bench; this leans forward very much. 16. The foot-ſtep to the treadles. 17. The breaſt-beam, being a croſs-bar that paſſes from one of the ſtandards to the other, ſo as to front the workman's breaſt: to this breaſt-bar is fixed a roll, upon which the ribbon paſſes in its way, to be rolled upon the roller, that turns a little below. 18. The clamps, or pieces of wood, in which the broaches that confine the treadles reſt. 19. The treadles are long narrow pieces of wood, to the ends of which the cords that move the liſſes are faſtened. 20. The treadle-cords are only diſtinguiſhed from the riding-cords by a board full of holes, which divide them, in order to prevent the plate-leads, which are tied to the high-liſſes, from pulling them too high when the workman's foot is off the treadle: which ſtop is made by a knot in the treadle-cord, too big to be forced through that hole in the board. 21. The lams are two pieces of thin narrow boards, only uſed in plain works, and then to ſupply the place of the long-harneſs. 22. The knee-roll, by which the weaver rolls up his ribbon as he ſees proper, or by bit and bit as it is finiſhed. 23. The back-rolls, on which the warp is rolled. It is to be obſerved, that there is always as many rolls as colours in the work to be wove. 24. The clamps, which ſupport the rollers. 25. The returning-ſticks, or, as others call them, the *returns*, or the *tumblers*, or *pulleys*, to which the tiers are tied, to clear the courſe of cords through the high-liſſes. 26. The catch-board for the tumblers. 27. The tire-board. 28. The buttons for the knee-rolls and treadle-board, deſcribed in N° 20.

It is ſtated in the proceedings of the National Inſtitute of France, that a report was preſented to that body concerning a new machine for weaving ribbed ſtockings. The advantages which this machine poſſeſſes are ſaid to be, that it may be erected at one-half of the expence of the Engliſh ſtocking frame, and that its movements are much lighter. The experience of its operations for two years has confirmed theſe advantages. Of the nature and conſtruction of this machine we have had no opportunity of obtaining any information; but we thought it worth while to inſert this ſhort notice, with the view of directing the attention of ſuch of our readers as may be intereſted in the improvement of ſuch manufactures.

WEB, a ſort of tiſſue or texture formed of threads interwoven with each other; ſome whereof are extended in length, and called the *warp;* others are drawn acroſs, and called the *woof*.

WEBERA, a genus of plants belonging to the claſs and order pentandria monogynia. See BOTANY *Index*.

WEBSTER, ALEXANDER, D. D. was the ſon of James Webſter, miniſter of the Tolbooth church in Edinburgh, and born in that city about the year 1707. He was only 13 years of age at the death of his father, and of courſe could derive little from parental inſtruction or example. He ſtudied at the univerſity of Edinburgh the ſeveral branches of learning with great approbation,

WEAVING.

Fig. 1.

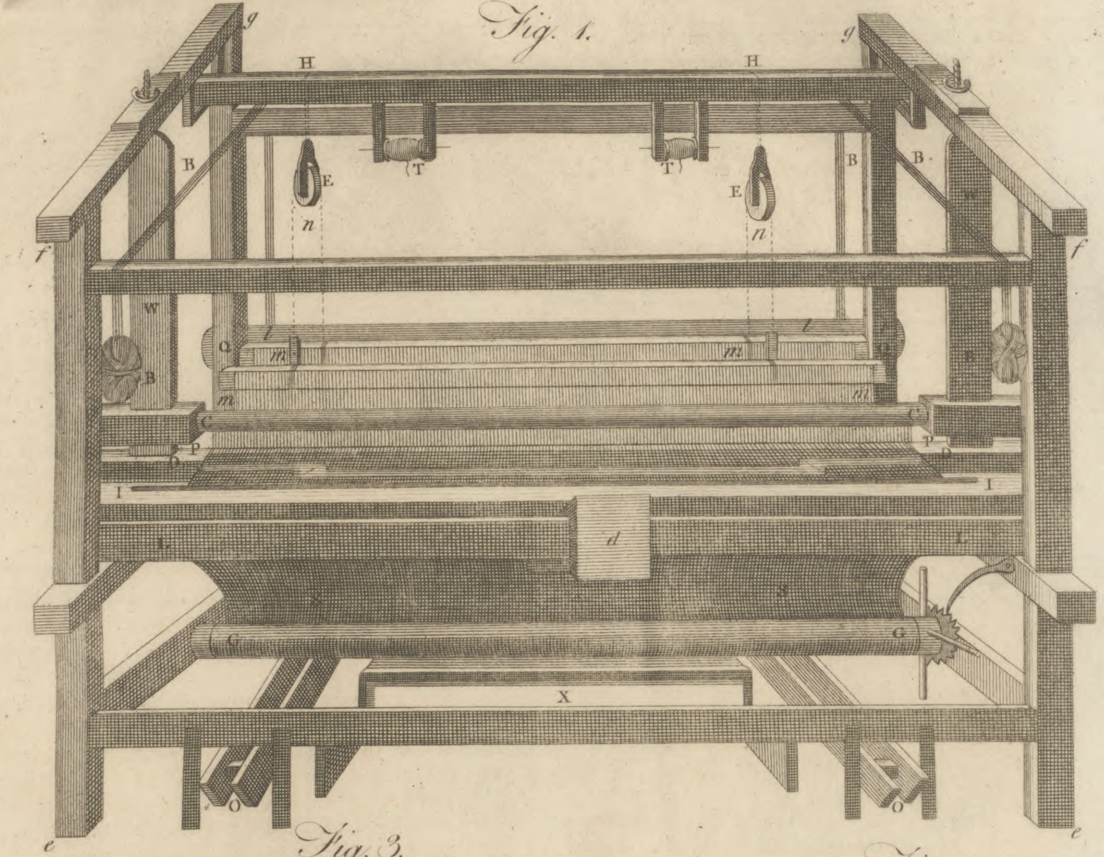


Fig. 3.

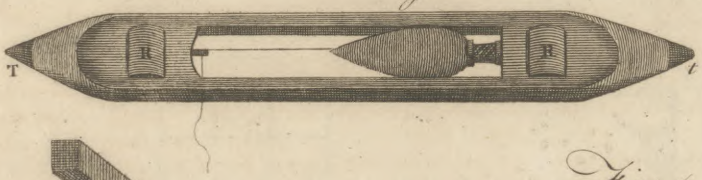


Fig. 2.

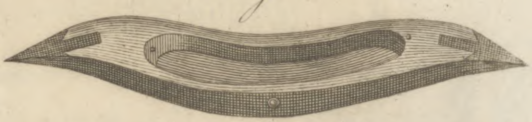
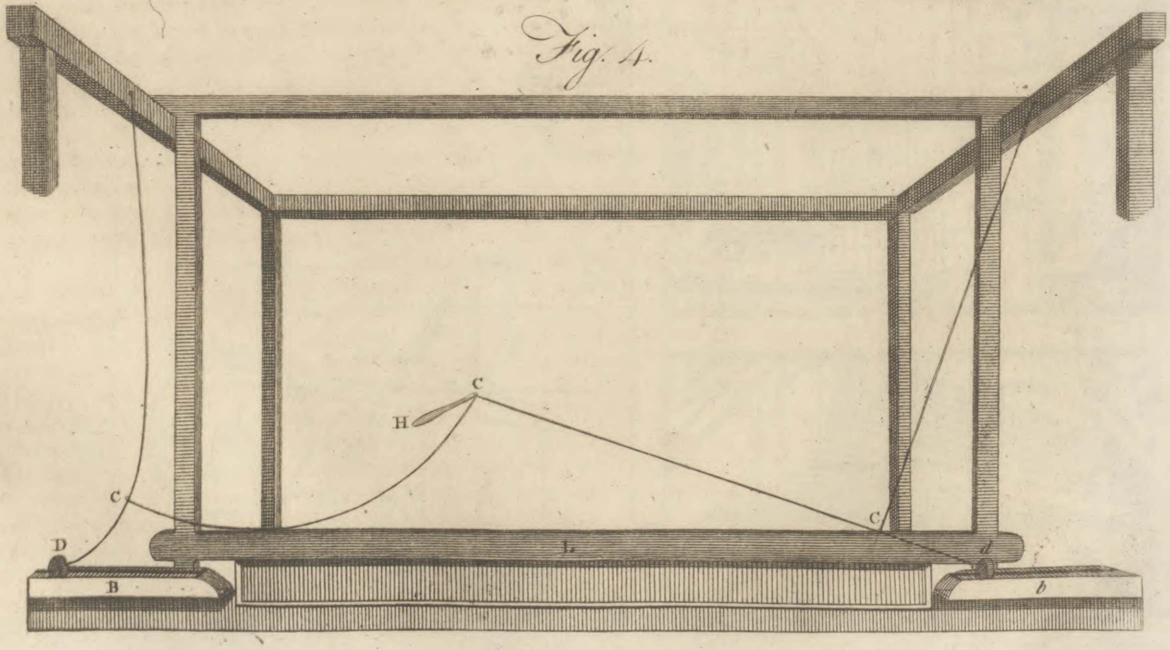


Fig. 4.



W. Train. Sculpt.

Fig. 5.

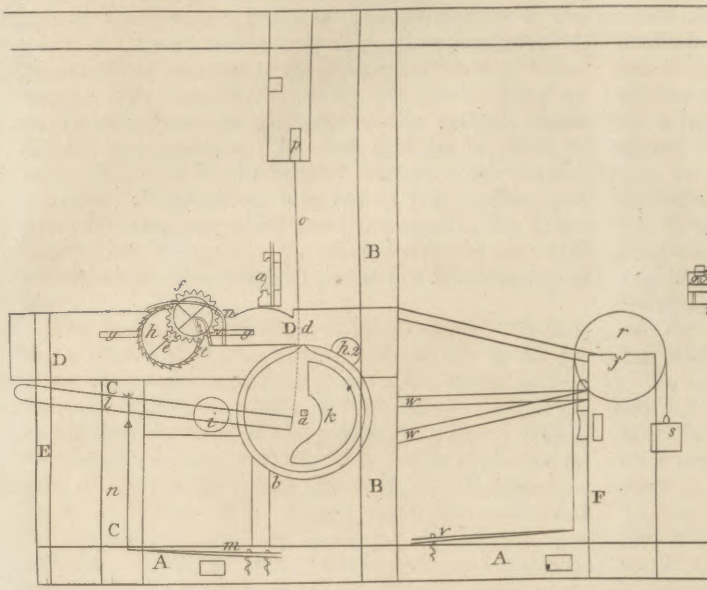


Fig. 6.

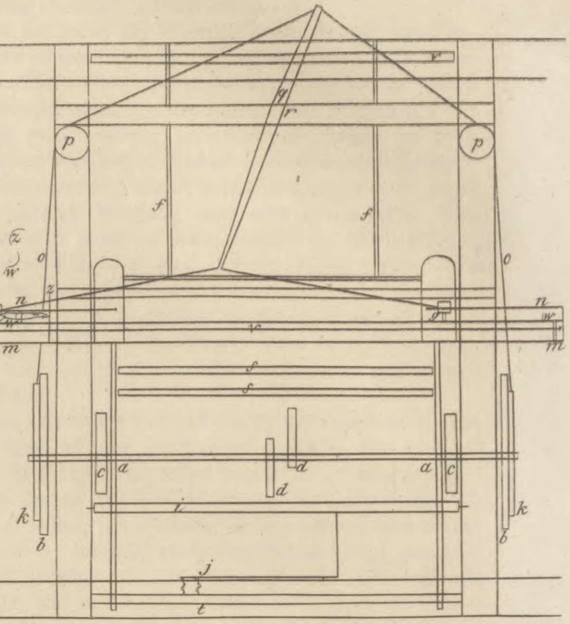


Fig. 7.

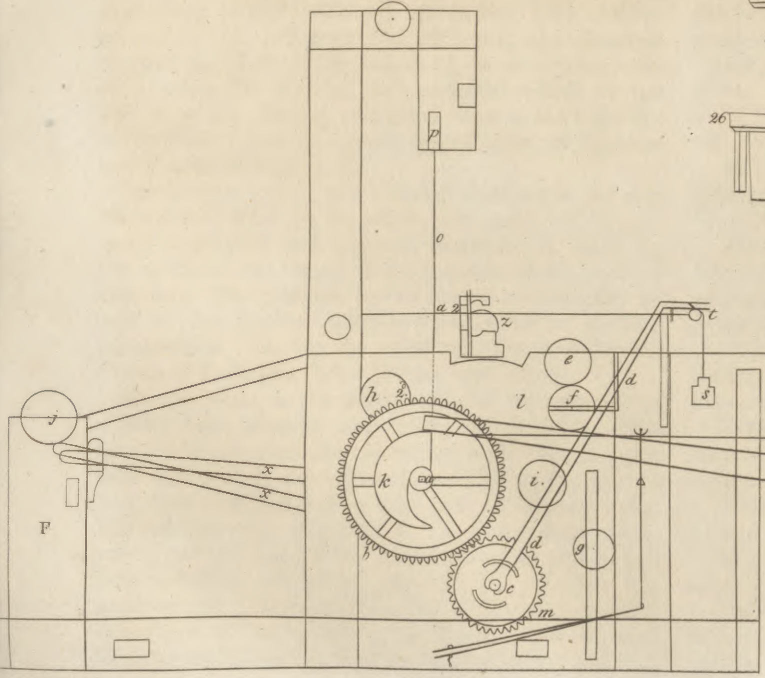
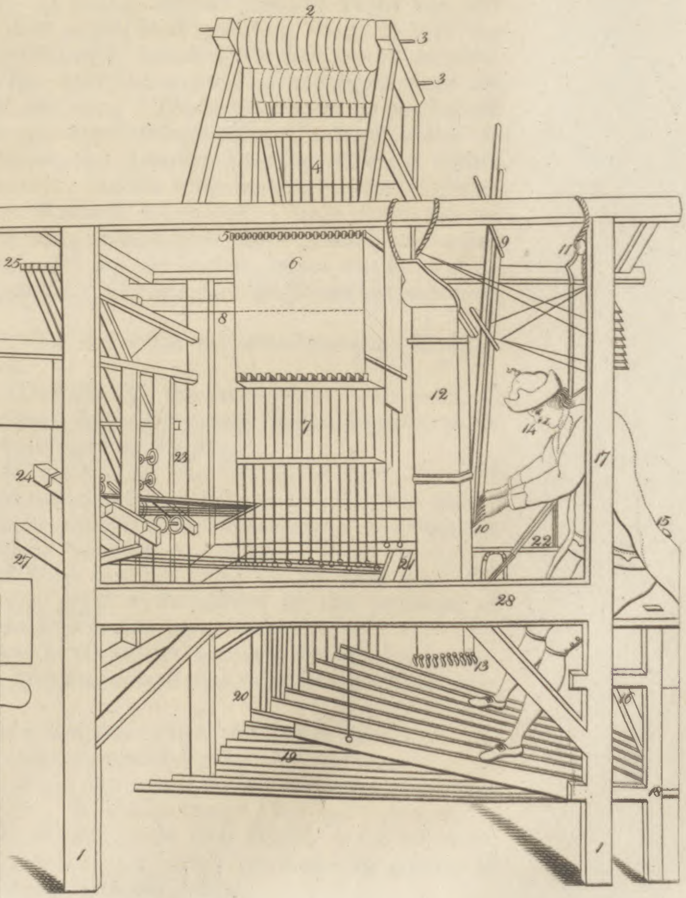


Fig. 8.



W. Archibald sc.

particularly thoſe connected with the mathematics, for which he diſcovered an early predilection. He afterwards attended the lectures of the profeſſor of divinity, and in the year 1733 he was ordained miniſter of the pariſh of Culroſs, and in June 1737, he was admitted to be one of the miniſters of the Tolbooth church of Edinburgh. His eloquence was noble and manly, his piety conſpicuous, and the diſcharge of his paſtoral duties faithful and laborious. To theſe qualities he added an enlightened zeal for the external intereſts of the church, a jealouſy of corruption, a hatred of falſe politics and tyrannical meaſures, which ſometimes expoſed him to calumny from the guilty, but ſecured him the eſteem of all who could value independence of ſoul and integrity of heart.

The proſperity of fortune which placed Mr Webſter in the church of his father, and reſtored him to the poliſhed ſociety of his native city, was not confined to theſe favours. Eleven days after his ſettlement in Edinburgh, he obtained the hand of Mary Erſkine, a young lady of conſiderable fortune, and nearly related to the noble family of Dundonald. The genius of Mr Webſter now began to unfold itſelf. Family connections extended his acquaintance with the nobility. Edinburgh then poſſeſſed a number of men, both in civil and eccleſiaſtical ſtations, who have ſaved or adorned their country. With theſe he was ſoon to co operate in defending the proteſtant intereſts from the arms and artifices of rebellion.

In the year 1733, five or ſix miniſters ſeceded from the church, and being anxious to draw away as many as poſſible from the communion which they had renounced, they invited down to Scotland in 1741, Mr George Whitefield, a young preacher of great piety and extraordinary pulpit talents. On his way to Dunfermline, he was met and entertained at Edinburgh by Mr Webſter and ſome of his brethren. From them he learned the ſtate of church parties in Scotland; and though he kept his promiſe of preaching firſt in Fife, he declined connecting himſelf with any particular ſect. Diſappointed of his influence and aſſiſtance, the Seceders aſcribed the effects of his preaching to ſorcery and the devil, while Mr Webſter, in a pamphlet which he publiſhed on the occaſion, attributed them to the influence of the Holy Spirit, an opinion regarded by the Seceders as unſpeakable wickedneſs.

In the year 1745, Mr Webſter remained in the city when it was taken by the rebels, and employed his univerſal popularity and vigorous eloquence in retaining the minds of the people in the intereſts of the houſe of Hanover. His exertions in this were not overlooked by moſt of the ſpirited gentlemen who acted in quelling the rebellion. He became an intimate friend of Duncan Forbes of Culloden, Lord Milton, and others.

He preſerved to the lateſt period of his career, that activity both of mind and body, which diſtinguiſhed him in the prime of life, obtaining at laſt his frequent wiſh and prayer, an eaſy and peaceful death, after a very ſhort indiſpoſition, on the 25th of January 1784. His remains were depoſited in the Grayfriars churchyard; and it is not a little remarkable that neither private friendſhip nor public generoſity has yet come forward to teſtify its regard for two of the moſt eminent characters of the church of Scotland. The aſhes of Webſter and Blair repoſe in the ſame cemetry, undiſtinguiſhed from the leſs illuſtrious dead. No monumental ſtone marks the place of their duſt.

Nature endowed Dr Webſter with ſtrong faculties, which were afterwards improved by a conſiderable ſhare of erudition. He was a maſter in the knowledge of the world and of human nature; his addreſs was engaging; his wit ſtrong as his mind; his convivial powers, as they are called, enchanting. He had a conſtitutional ſtrength againſt intoxication, which made it dangerous in moſt men to attempt bringing him into ſuch a ſtate. His character as a miniſter was popular in the extreme. His voice was harmonious, and his figure noble. To the poor he was a father and a friend, a liberal patron to poor ſtudents. In his perſon he was tall, and of a thin and meagre habit. His features were ſtrongly marked, and the conformity of the whole indicated genius and independence.

To him the widows of the clergy are indebted for the eſtabliſhment of the celebrated *Scheme*, the plan of which he matured in his mind ſoon after he was appointed a miniſter of the Tolbooth church. By it the widows of miniſters are entitled to the annual ſum of 10, 15, 20, or 25 pounds, according as the clergy pay into the fund yearly, 2l. 12s. 6d.—3l. 18s. 9d.—5l. 5s. or 6l. 11s. 3d, or to their children in ſums of 100—150—200—or 250l, in favour of which an act of parliament was obtained in terms of a petition (17 Geo. II.) with liberty to employ the ſurplus of the annual payments and expences in loans of 30l. each among the contributors, and to put out the remainder at intereſt, on proper ſecurity. A ſecond act was procured in the 22d year of the ſame reign (1748) granting liberty to raiſe the capital to 80,000l, including the ſums lent to contributors. The fund is conceived to commence from the 25th March 1744. This was followed by another act in the year 1770, diſcontinuing the loan granted to contributors, and granting liberty to raiſe the capital to 100,000l.; and the whole economy of the inſtitution was then fixed and determined, a report of the ſtate of the fund being ordered to be made annually to the General Aſſembly by the truſtees, which was to be afterwards printed. The ſucceſs of the ſcheme has been complete.

WEDGE, one of the mechanical powers. See MECHANICS.

WEDNESDAY, the fourth day of the week, ſo called from a Saxon idol named *Woden*, ſuppoſed to be Mars, worſhipped on this day.

Aſh-WEDNESDAY, the firſt day of Lent, ſo called from the cuſtom obſerved in the ancient Chriſtian church of penitents expreſſing their humiliation at this time, by appearing in ſack-cloth and aſhes.

WEED, a common name for all rank and wild herbs, that grow of themſelves, to the detriment of other uſeful herbs they grow among.

WEED, in the miners language, denotes the degeneracy of a load or vein of fine metal into an uſeleſs marcaſite.

WEEDS, alſo denote a peculiar habit, worn by the relicts of perſons deceaſed, by way of mourning.

WEEK, in chronology, a diviſion of time compriſing ſeven days. See *PLANETARY Days* and SABBATH.

Paſſion-WEEK, or the *Holy WEEK*, is the laſt week in Lent, wherein the church celebrates the myſtery of our Saviour's death and paſſion.

WEEKS Ember. See Ember.

Feaſt of WEEKS. See Pentecost.

WEEVER. See Trachinus, Ichthyology *Index*.

WEEVIL, in *Zoology*, a ſpecies of curculio. See Curculio, Entomology *Index;* and for the method of deſtroying this troubleſome and deſtructive inſect, ſee Granary and Vermin.

WEIGELIA, a genus of plants belonging to the claſs and order pentandria monogynia. See Botany *Index*.

WEIGH, a weight of cheeſe, wool, &c. containing 256 pounds avoirdupois. Of corn, the weigh contains 40 buſhels; of barley or malt, ſix quarters. In ſome places, as Eſſex, the weigh of cheeſe is 300 pounds.

WEIGHING, the act of examining a body in the balance to find its weight.

WEIGHING Anchor, is the drawing it out of the ground it had been caſt into, in order to ſet ſail, or quit a port, road, or the like.

WEIGHT, in *Phyſics*, a quality in natural bodies, whereby they tend downwards towards the centre of the earth. Or, weight may be defined in a leſs limited manner, to be a power inherent in all bodies whereby they tend to ſome common point, called the *centre of gravity*, or, to ſpeak more accurately, to one another: and that with a greater or leſs velocity, as they are more or leſs denſe, or as the medium they paſs through is more or leſs rare. See Mechanics.

Weight, in commerce, denotes a body of a known weight appointed to be put in the balance againſt other bodies whoſe weight is required.

The ſecurity of commerce depending, in a good meaſure, on the juſtneſs of weights, which are uſually of lead, iron, or braſs, moſt nations have taken care to prevent the falſification thereof, by ſtamping or marking them by proper officers, after being adjuſted by ſome original ſtandard. Thus, in England, the ſtandard of weights is kept in the exchequer by a particular officer, called the *clerk of the market*.

Weights may be diſtinguiſhed into ancient and modern.

I. Ancient Weights.

1. Thoſe of the ancient Jews, reduced to the Engliſh troy weight, will ſtand as in the following table:

			lb.	oz.	dwt.	gr.
Shekel			0	0	9	$2\frac{4}{7}$
60	Maneh		2	3	6	$10\frac{2}{7}$
3000	50	Talent	113	10	1	$10\frac{2}{7}$

2. Roman weights, reduced to Engliſh troy weight, will ſtand as is in the following table:

										oz.	dwt.	gr
Lentes										0	0	$0\frac{85}{112}$
4	Siliquæ									0	0	$3\frac{1}{28}$
12	3	Obolus								0	0	$9\frac{3}{28}$
24	6	2	Scriptulum							0	0	$18\frac{3}{14}$
72	18	6	3	Drachma						0	2	$6\frac{9}{14}$
96	24	8	4	$1\frac{1}{3}$	Sextula					0	3	$0\frac{6}{7}$
144	36	12	6	2	$1\frac{1}{2}$	Sicilicus				0	4	$13\frac{2}{7}$
192	48	16	8	$2\frac{2}{3}$	2	$1\frac{1}{3}$	Duella			0	6	$1\frac{5}{7}$
576	144	48	24	8	6	4	3	Uncia		0	18	$5\frac{1}{7}$
6912	1728	576	288	96	72	48	36	12	Libra	10	18	$13\frac{5}{7}$

The Roman ounce is the Engliſh avoirdupois ounce, which they divided into ſeven denarii, as well as eight drachmas.

3. *Attic Weights.*

			Engliſh Troy Weight			
			lb.	oz.	dwt.	gr.
Drachma			0	0	2	16.9
100	Mina		1	1	10	10
6000	60	Talent	67	7	5	0

II. Modern Weights.

1. *Engliſh Weights.*—Mr Renardſon, in a paper publiſhed in the Philoſophical Tranſactions, has proved, that at firſt there was but one weight in England, and that this was the avoirdupois. Troy weight was introduced in the time of Henry VII.: At preſent, both the troy and avoirdupois weights are uſed in England. Troy weight ſeems to have derived its name from *Troyes*, a town in France, where a celebrated fair was kept. It is uſed for weighing gold, ſilver, jewels, ſilk, and all liquors. The avoirdupois is uſed for weighing other things.

Table of Troy Weight, as uſed by the

Goldſmiths, &c.

Grains.			
24	Penny-weights.		
480	20	Ounce.	
5760	240	12	Pound.

Apothecaries.

Grains.				
20	Scruple. ℈			
60	3	Dram. ʒ		
480	24	8	Ounce. ℥	
5760	288	96	12	Pound.

The troy pound in Scotland, which by ſtatute is to be the ſame as the French pound, is commonly ſuppoſed equal

equal to 15 ounces and three quarters troy Engliſh weight, or 7560 grains. But by a mean of the ſtandards kept by the dean-of-guild of Edinburgh, it weighs 7599$\frac{2}{32}$ or 7600 grains.

TABLE of Avoirdupois Weight.

Drams.					
16	An ounce.				
256	16	A pound.			
7168	448	28	A quarter.		
28672	1792	112	4	A hundred.	
573440	35840	2240	80	20	A ton.

The avoirdupois pound is equal to 7004 troy grains, the avoirdupois ounce to 437.75 grains; and it follows of conſequence, that the troy pound is to the avoirdupois pound as 88 to 107 nearly; for as 88 to 107, ſo is 5760 to 7003.636: that the troy ounce is to the avoirdupois ounce as 80 to 73 nearly; for as 80 to 73, ſo is 480 to 438. An avoirdupois pound is equal to 1lb. 2 oz. 11dwts. 20 gr. troy; a troy ounce is equal to 1 oz. 1.55dr. avoirdupois; an avoirdupois dram contains 27.34375 grains; 175 troy pounds are equal to 144 avoirdupois pounds.

The moneyers have a peculiar ſubdiviſion of the grain troy: thus,

The	Grain	into	20 Mites,
	Mite		24 Droits.
	Droit		20 Periots.
	Periot		24 Blanks.

The Engliſh weights are uſed in the United Provinces of America.

2. *French Weights.*—Different weights were formerly uſed in moſt of the different provinces of France: Theſe, however, have undergone very material alterations ſince the revolution in that kingdom. See MEASURE. But as a knowledge of the ancient weights of that country is of importance, on account of the books in which they are uſed, we inſert the following tables. The Paris pound contains 16 ounces, and is divided two ways.

Grains.					
24	Penny-weight.				
72	3	Gros.			
576	24	8	Ounce.		
4608	192	64	8	Marc.	
9216	384	128	16	2	Pound.

Half-ounce.						
2	Ounce.					
4	2	Half-quarter pound.				
8	4	2	Quarter-pound.			
16	8	4	2	Half-pound.		
32	16	8	4	2	Pound.	
3200	1600	800	400	200	100	Quintal.

The weights of the firſt diviſion are uſed to weigh gold, ſilver, and the richer commodities; and the weights of the ſecond diviſion for commodities of leſs value.

The Paris 2 marc, or pound weight, is equal to 7560 grains troy, and the Paris ounce equal to 472.5 grains troy.

	lb.	oz.	dwt.	gr.	
The Paris pound =	1	3	15	0	troy.
The Paris ounce =	0	0	19	16.5	troy.

A grain troy = 1.2186507 of a Paris grain.

But the pound was not the ſame throughout France. At Lyons, *e. gr.* the city pound was only 14 ounces: ſo that 100 Lyons pounds, made only 86 Paris pounds. But beſide the city pound, they had another at Lyons for ſilk, containing 15 ounces. At Thoulouſe, and throughout the Upper Languedoc, the pound was 13 ounces and a half of Paris weight. At Marſeilles, and throughout Provence, the pound was 13½ ounces of Paris weight. At Rouen, beſide the common Paris pound and marc, they had the weight of the vicomte; which was 16 ounces, a half, and five-ſixths of the Paris weight. The weights enumerated under the two articles of Engliſh and French weights are the ſame that are uſed throughout the greateſt part of Europe; only under ſomewhat different names, diviſions, and proportions.

French weights were formerly uſed in all the French American ſettlements.

3. *Dutch Weights.*—The weight uſed in Amſterdam and all over Holland is called *Troy weight*, and is exactly the ſame with that uſed at Bruſſels. The Dutch weights are as follows:

Deuſkens.						
2	Troyken.					
4	2	Vierling.				
16	8	4	As.			
512	256	128	32	Angle.		
10240	5120	2560	640	20	Ounce.	
81920	40960	20480	5120	160	8	Marc.

The marc is equal, according to M. Tillet, to 4620 French grains.

The Amſterdam pound uſed in commerce is divided into 16 ounces, 32 loots, or 128 drams. This pound contains 2 marcs troy, and ought therefore to weigh only 10240 *as*: but it weighs 10280; ſo that it is a little heavier than the troy pound of Amſterdam: 256lb. of commerce are equal to 257lb. troy of Holland. Two different pounds are uſed by apothecaries; the one containing 2 marcs, the other only $1\frac{1}{2}$. The firſt is called *arſenic* pound weight; it contains 16 ounces, the ounce 8 drams, the dram 8 ſcruples, the ſcruple 20 grains. The ſecond is called the *apothecary's* pound; it is divided into 12 ounces, or 24 loots. Three arſenic pounds are equal to 4 apothecary's pounds.

The Dutch ſtone - = 8 commercial lb.
The Liſpundt, or Ll. = 15
The hundred weight = 100
The Schippondt, or Sch. lb. = 300

4. *Spaniſh Weights.*—The marc of Caſtile, uſed for weighing gold and ſilver, is divided as follows:

Grains (gold weight).								
$1\frac{1}{24}$	Grain (ſilver weight).							
12	$11\frac{13}{25}$	Tomine (gold weight).						
$12\frac{1}{2}$	12	$1\frac{1}{24}$	Tomine (ſilver weight).					
$37\frac{1}{2}$	36	$3\frac{1}{8}$	3	Adarme				
75	72	$6\frac{1}{4}$	6	2	Ochava.			
96	$92\frac{4}{25}$	8	$7\frac{17}{25}$	$2\frac{14}{25}$	$1\frac{7}{25}$	Caſtellano.		
600	576	50	48	16	8	$6\frac{1}{4}$	Ounce.	
4800	4608	400	384	128	64	50	8	Marc.

The marc, according to Tillet, is equal to 7 oz. 4 gros, 8 grains French, which is equal to 4785 *as* of Holland. One hundred marcs of Caſtile = about $93\frac{1}{2}$ marcs of Holland; 100 marcs of Holland = 107 marcs of Caſtile. Medicines are ſold by the ſame marc; but it is divided differently, containing 8 ounces, 64 drachms, 192 ſcruples, 384 obolos, 1152 caracteras, 4608 grains.

The Spaniſh commercial pound is divided into two marcs, called *marcs of Tejo*, each of which is equal to the marc of Caſtile. This pound is divided into 16 ounces, 256 adarmes, 9,216 grains.

5. *Weights of Portugal.*—The Liſbon marc for eſſaying ſilver coin of 12 deniers, and the denier of 24 grains. The marc of Portugal for weighing gold and ſilver is equal, according to Tillet, to 7 ounces $3\frac{1}{2}$ gros, and 34 grains French, which makes 4776 *as* of Holland; ſo that it is exactly the ſame with the Liſbon pound. It is divided into 8 ounces, 64 outavas, 192 ſcruples, 4608 grains.

The pound conſiſts of 2 marcs, 16 ounces, or 96 outavas; the arroba of 32 lb.; the quintal of 4 arrobas, or 128 lb. 100 Oporto pounds make $87\frac{1}{6}$th pounds of commerce of Amſterdam.

6. *Weights of Italy.*—*Genoa.* Two kinds of weights are uſed at Genoa, the *peſo groſſo* (heavy weight), and the *peſo ſottile* (light weight): the latter is uſed for weighing gold and ſilver, the former for other things. The pound of the peſo ſottile is equal, according to Tillet, to 1 marc, 2 ounces, $2\frac{1}{2}$ gros, 30 grains French. It is divided into 8 ounces, the ounce into 24 deniers, and the denier into 24 grains. The pound of the peſo groſſo is equal to 1 marc, 2 ounces, 3 gros, 5 grains, French. It is divided into 12 ounces:

The cantaro = 100 lbs. peſo groſſo.
The rubbo = 25 lbs.
The rotolo = $1\frac{1}{2}$ lb.
100 lbs. peſo groſſo = $64\frac{1}{3}$ lb. of commerce of Amſterdam.
100 lbs. peſo ſottile = 129 marcs troy of Holland.

Rome. The Roman pound conſiſts of 12 ounces, the ounce of 24 deniers, the denier of 24 grains. The Roman pound, according to Tillet, is equal to 1 marc, 3 ounces, $\frac{1}{2}$ gros, 14 grains, French.

Venice. The marc for weighing gold and ſilver contains 8 ounces, 32 quarti, 1152 carati, or 4608 grani. An hundred marcs of Venice = $97\frac{1}{5}$ marcs troy of Holland, 100 marcs of Holland = 103 of Venice. In Venice they alſo uſe a *peſo groſſo* and *peſo ſottile*. 100 lbs. peſo groſſo = $94\frac{4}{5}$ commercial lbs. of Amſterdam. 100 lbs. peſo ſottile = $61\frac{2}{7}$ ditto.

7. *Swediſh Weights.*—The marc for weighing gold and ſilver is equal to 16 lods, 64 quentins, or 4384 as. The pound of 32 lods, uſed for weighing food, is equal, according to Tillet, to 1 marc, 5 ounces, 7 gros, 8 grains French, which makes $8848\frac{1}{2}$ as troy of Holland. This anſwers exactly to the weight of the different pounds, as fixed in Sweden, viz. 8848 as = the pound for weighing articles of food; $7821\frac{79}{125}$ as = marc uſed in the mines; $7450\frac{2}{125}$ as = marc uſed in towns and in the country; $7078\frac{2}{5}$ as = marc uſed for weighing iron; 7416 as = pound uſed in medicine.

The ſkippund = 400 lbs. for weighing food.
The centner = 120 lbs.
The waag = 165 lbs.
The ſten = 32 lbs.
The Swediſh as = 1 as of Holland troy.

8. *German Weights.*—*Vienna.* The marc of Vienna for weighing gold and ſilver is divided into 16 loths, 64 quintals, or 256 deniers or pfenings; the loth into 4 quintals, or 16 pfenings. This marc, according to Tillet, is equal to 1 marc, 1 ounce, 1 gros, 16 grains, French, = 5831 as troy Holland. The pound of Vienna is divided into 2 marcs, or 4 viertings; the mark into 8 ounces, 16 loths, 64 quintals, or 266 pfenings.

Hamburgh. The marc for eſſaying gold is divided into 24 carats; the carat into 12 grains. The marc for ſilver is divided into 16 loths, and the loth into 18 grains. Theſe marcs conſiſt each of 288 grains, and are therefore equal. This marc, uſed in Hamburgh for gold and ſilver, is the marc of Cologne, which is equal, according to Tillet, to 7 ounces, 5 gros, $7\frac{3}{4}$ grains, French, = 4866 as troy of Holland. It is divided into 8 ounces, 16 loths, 64 quentins, 256 pfenings, 4352 eſches, or 65536 richt pfenings theile. The apothecary pound uſed in Hamburgh, and almoſt all Germany, is divided into 12 ounces, 96 drachms, 288 ſcruples, or 5760 grains; an ounce is equal to 621 as of Holland.

The pound of commerce is equal, according to Tillet, to 10085 as of Holland; for half a pound is equal to 7 ounces, 7 gros, 23 grains, French. This pound is divided into 16 ounces, 32 loths, 128 quentins, or 512 pfenings.

9. *Ruſſian Weights.*—The berckowitz = 400 lbs.
The poud - - = 40 lbs.

The pound is divided into 32 loths, or 96 ſolotnuks. One hundred Ruſſian lbs. = $166\frac{1}{2}$ marcs, or $82\frac{4}{5}$ lbs. of Amſterdam. One hundred lbs. of commerce of Amſterdam = $120\frac{3}{4}$th lbs. of Ruſſia.

10. *Weights uſed in the ſeveral parts of Aſia, the Eaſt Indies, China, Perſia, &c.*—In Turkey, at Smyrna, &c. they uſe the batman, or battemant, containing $7\frac{1}{2}$ occos; the occo contains 4 chekys or pounds, each of which, according to Tillet, is equal to 1 marc 2 oz. 3 gros. 28 gr. French. The Turkiſh weights are divided as follows:

Cantaras.	Batmans.	Occos.	Rotolos.	Chekis.	Meſcals.	Drachms.
1 =	$7\frac{1}{2}$ =	44 =	100 =	176 =	$11733\frac{1}{3}$ =	17600
	1 =	6 =	$13\frac{1}{11}$ =	24 =	1600 =	2400
		1 =	$2\frac{3}{11}$ =	4 =	$266\frac{2}{3}$ =	400
			1 =	$1\frac{19}{28}$ =	$117\frac{1}{3}$ =	176
				1 =	$66\frac{2}{3}$ =	100
					1 =	$1\frac{1}{2}$

At Aleppo there are three ſorts of rottos; the firſt 720 drachms, making about 7 pounds Engliſh, and ſerving to weigh cottons, galls, and other large commodities; the ſecond is 680 drachms, uſed for all ſilks but white ones, which are weighed by the third rotto of 700 drachms. At Seyda the rotto is 600 drachms.

The other ports of the Levant, not named here, uſe ſome of theſe weights; particularly the occa, or ocqua, the rottoli, and rotto.

The Chineſe weights are, the piece for large commodities: it is divided into 100 catis or cattis, though ſome ſay into 125; the cati into 16 taels or tales, each tael equivalent to $1\frac{1}{5}$ of an ounce Engliſh, or the weight of one rial and $\frac{1}{12}$, and containing 12 mas or maſſes, and each mas 10 condrins. So that the Chineſe piece amounts to 137 pounds Engliſh avoirdupois, and the cati to 1 pound 8 ounces. The picol for ſilk containing 66 catis and $\frac{3}{4}$; the bahar, bakaire, or barr, containing 300 catis.

Tonquin has alſo the ſame weights, meaſures, &c. as China. Japan has only one weight, viz. the cati; which, however, is different from that of China, as containing 20 taels. At Surat, Agra, and throughout the ſtates of the Great Mogul, they uſe the man, or maund, whereof they have two kinds; the king's maund, or king's weight; and the maund ſimply; the firſt uſed for the weighing of common proviſions, containing 40 ſeers, or ſerres; and each ſeer a juſt Paris pound. The common maund, uſed in the weighing of merchandiſe, conſiſts likewiſe of 40 ſeers, but each ſeer is only eſtimated at 12 Paris ounces, or $\frac{3}{4}$ of the other ſeer.

The maund may be looked upon as the common weight of the Eaſt Indies, though under ſome difference of name, or rather of pronunciation; it being called *mao* at Cambaya, and in other places *mein* and *maum*. The ſeer is properly the Indian pound, and of univerſal uſe; the like may be ſaid of the bahar, tael, and catti, above mentioned.

The weights of Siam are the piece, containing two ſhans or cattis; but the Siameſe catti is only half the Japaneſe, the latter containing 20 taels and the former only 10; though ſome make the Chineſe catti only 16 taels, and the Siameſe 8. The tael contains 4 baats, or ticals, each about a Paris ounce; the baat 4 ſelings or mayons; the mayon 2 fouangs; the fouang 4 payes; the paye 2 clams; the ſompaye half a fouang.

It is to be obſerved, that theſe are the names of their coins as well as weights; ſilver and gold being commodities there ſold, as other things, by their weights.

In the iſle of Java, and particularly at Bantam, they uſe the gantan, which amounts to near 3 Dutch pounds. In Golconda, at Viſapour, and Goa, they have the furatelle, containing 1 pound 14 ounces Engliſh; the mangalis, or mangelin, for weighing diamonds and precious ſtones, weighing at Goa 5 grains, at Golconda, &c. $5\frac{1}{2}$ grains. They have alſo the rotolo, containing $14\frac{1}{4}$ ounces Engliſh; the metricol, containing the ſixth part of an ounce; the wall for piaſtres and ducats, containing the 73d part of a rial.

In Perſia they uſe two kinds of batmans or mans; the one called *cahi* or *cheray* which is the king's weight, and the other *batman of Tauris*. The firſt weighs 13 pounds 10 ounces Engliſh; the ſecond $6\frac{1}{2}$ pounds. Its diviſions are the ratel, or a 16th; the derhem, or drachm, which is the 50th; the meſchal, which is half the derhem; the dung, which is the ſixth part of the meſchal, being equivalent to 6 carat grains; and, laſtly, the grain, which is the fourth part of the dung. They have alſo the vakie, which exceeds a little our ounce; the ſah-cheray, equal to the 1170th part of the derhem; and the toman, uſed to weigh out large payments of money without telling; its weight is that of 50 abaſſes.

11. *Weights at Cairo in Egypt.*—Almoſt every kind of goods has its own weight; theſe are regulated by the cantaren or principal weight.

	Rotels.
The ordinary cantaren, or hundred weight, weighs	100
The cantaren of quickſilver and tin	102
coffee, wine, and iron	105
ivory	100
almonds and other fruits	115
woods for dying	120
arſenic and other drugs	125
minium and cinnabar	130
gum-arabic, aloes, and other aromatics	133

The ratel or rotoli is nearly equal to the pound of Marſeilles; 108 lbs. of Marſeilles are equal to 110 rotels. The Marſeilles pound conſiſts of 13 ounces of Paris; ſo that the 100 lbs. of Marſeilles are equal to 81 lbs. Paris, and 100 lbs. Paris = 123 lbs. of Marſeilles.

We ſhall ſubjoin here Mr Ferguſon's table for comparing the Engliſh avoirdupois pound with foreign pounds:

London pound	1.0000	Bruges	1.0204
Antwerp	1.04	Calabria	0.73
Amſterdam	1.1111	Calais	0.9345
Abeville	1.0989	Dieppe	1.0989
Ancona	0.78	Dantzic	0.862
Avignon	0.8928	Ferrara	0.75
Bourdeaux	1.0989	Flanders	0.9433
Bologna	0.8	Geneva	1.07

Ferguſon's Tables and Tracts.

Genoa, groſs	0.7	Rochelle	0.8928
Hamburgh	1.0865	Rome	0.7874
Liſbon	1.135	Rouen	1.1089
Leghorn	0.75	Seville	0.9259
Norimberg	1.1363	Thoulouſe	0.8928
Naples	0.71	Turin	0.82
Paris	1.1235	Venice	1.06
Prague	1.2048	Vienna	1.23
Placentia	0.72		

In order to ſhow the proportion of the ſeveral weights uſed throughout Europe, we ſhall add a reduction of them to one ſtandard, viz. the London pound.

The 100lb. of England, Scotland, and Ireland are equal to

lb.	oz.	
91	8	of Amſterdam, Paris, &c,
96	8	of Antwerp or Brabant.
88	0	of Rouen, the viſcounty weight.
106	0	of Lyons, the city weight.
90	9	of Rochelle.
107	11	of Thoulouſe and Upper Languedoc.
113	0	of Marſeilles or Provence.
81	7	of Geneva.
93	5	of Hamburgh.
89	7	of Francfort, &c.
96	1	of Leipſic, &c.
137	4	of Genoa.
132	11	of Leghorn.
153	11	of Milan.
152	0	of Venice.
154	10	of Naples.
97	0	of Seville, Cadiz, &c.
104	13	of Portugal.
96	5	of Liege.
112	$\frac{2}{3}$	of Ruſſia.
107	$\frac{1}{24}$	of Sweden.
89	$\frac{1}{2}$	of Denmark.

A curious weighing machine was ſome time ago invented by M. Hanin of Paris, whereby the weights of the principal countries in Europe, and the relative proportions they bear to each other, are ſhown at one view. For this he received a bounty of 20 guineas from the Society inſtituted at London for the encouragement of Arts, Manufactures, and Commerce. The following is a deſcription of this ingenious machine.

Plate DLXXVII. Fig. 1.

Figure 1. repreſents the back of the machine, which being ſuſpended by the ring A, and a weight hung to the hook B, the ſpring C, C, C, made faſt by ſtrong ſcrews at *g*, is drawn downwards; and the bar D having a rack thereon at *e*, turns the pinion *f*, in proportion to the weight of the body hanging thereto. Figure 2. ſhows the face of the machine, on which is a number of concentric circles, and the weights of ſeveral countries of Europe engraved thereon, as expreſſed by the words on a line with them. In the centre of this face is a ring fixed to the ſmall plate, turned by the pinion *f*, ſhown at figure 1. From this ring a hand projects, which, by the turning of the pinion, points to ſuch part of the circle as is marked with the weight hung to the hook B; and thereby ſhows what weight of any of the countries mentioned, is equal to the pounds troy of London, which are engraved on the outer circle, or to the pounds avoirdupois, which are engraved on the ſecond circle, and ſo of the reſt. A ſlider moves on the hand, which may be brought to any of the circles at pleaſure, in order to point out the relative weight with greater preciſion.

Fig. 2.

Many attempts have been made to introduce an uniformity of weights and meaſures into the commercial world; but hitherto they have all failed. The accompliſhment of ſuch an undertaking would be of infinite advantage to mankind, and certainly claims the moſt ſerious attention of thoſe who by their ſituation can alone bring it about. The undertaking is indeed difficult, but ſurely not impoſſible. Something of this kind has been attempted and adopted in France; and, as the method is ſimple, and exceedingly well adapted for calculation, it ſurely deſerves to be imitated. See MEASURE.

WEIGHT of Air. See PNEUMATICS, N° 14—19.

Regulation of WEIGHTS and Meaſures, is a branch of the king's prerogative. See PREROGATIVE and MEASURE.

As weight and meaſure are things in their nature arbitrary and uncertain, it is therefore expedient that they be reduced to ſome fixed rule or ſtandard: which ſtandard it is impoſſible to fix by any written law or oral proclamation; for no man can, by words only, give another an adequate idea of a foot rule, or a pound weight. It is therefore neceſſary to have recourſe to ſome viſible, palpable, material ſtandard; by forming a compariſon with which all weights and meaſures may be reduced to one uniform ſize; and the prerogative of fixing this ſtandard, our ancient law veſted in the crown, as in Normandy it belonged to the duke. This ſtandard was originally kept at Wincheſter: and we find in the laws of King Edgar, near a century before the conqueſt, an injunction that the one meaſure, which was kept at Wincheſter, ſhould be obſerved throughout the realm. Moſt nations have regulated the ſtandard of meaſures of length by compariſon with the parts of the human body; as the palm, the hand, the ſpan, the foot, the cubit, the ell (*ulna* or arm), the pace, and the fathom. But as theſe are of different dimenſions in men of different proportions, our ancient hiſtorians inform us, that a new ſtandard of longitudinal meaſure was aſcertained by King Henry the Firſt; who commanded that the *ulna*, or ancient ell, which anſwers to the modern yard, ſhould be made of the exact length of his own arm. And one ſtandard of meaſure of length being gained, all others are eaſily derived from thence; thoſe of greater length by multiplying, thoſe of leſs by dividing, that original ſtandard. Thus, by the ſtatute called *compoſitio ulnarum et perticarum*, five yards and a half make a perch; and the yard is ſubdivided into three feet, and each foot into 12 inches; which inches will be each of the length of three grains of barley. Superficial meaſures are derived by ſquaring thoſe of length; and meaſures of capacity by cubing them. The ſtandard of weights was originally take from corns of wheat, whence the loweſt denomination of weights we have is ſtill called a *grain*; 32 of which are directed, by the ſtatute called *compoſitio menſurarum*, to compoſe a pennyweight, whereof 20 make an ounce, 12 ounces a pound, and ſo upwards. And upon theſe principles the firſt ſtandards were made; which, being originally ſo fixed by the crown, their ſubſequent regulations have been generally made by the king in parliament. Thus, under King Richard I. in his parliament holden at Weſtminſter, A. D. 1197, it was ordained that there ſhould be only one weight and one meaſure

meaſure throughout the kingdom, and that the cuſtody of the aſſize, or ſtandard of weights and meaſures, ſhould be committed to certain perſons in every city and borough; from whence the ancient office of the king's aulnager ſeems to have been derived, whoſe duty it was, for a certain fee, to meaſure all cloths made for ſale, till the office was aboliſhed by the ſtatute 11th and 12th William III. c. 20. In King John's time this ordinance of King Richard was frequently diſpenſed with for money; which occaſioned a proviſion to be made for enforcing it, in the great charters of King John and his ſon. Theſe original ſtandards were called *pondus regis*, and *menſura domini regis*, and are directed by a variety of ſubſequent ſtatutes to be kept in the exchequer chamber, by an officer called the *clerk of the market*, except the wine gallon, which is committed to the city of London, and kept in Guildhall.

The *Scottiſh* ſtandards are diſtributed among the oldeſt boroughs. The elwand is kept at Edinburgh, the pint at Stirling, the pound at Lanark, and the firlot at Linlithgow.

Various ſtatutes have been enacted for regulating and enforcing an uniformity of weights and meaſures; and, by the articles of union, the Engliſh ſtandards are eſtabliſhed by law over all Great Britain. But the force of cuſtom is ſo ſtrong, that theſe ſtatutes have been ill obſerved. The Scottiſh ſtandards are ſtill univerſally retained for many purpoſes; and likewiſe a variety of local weights and meaſures are uſed in particular places of both countries, which differ from the general ſtandards of either.

WEINMANNIA, a genus of plants of the claſs *octandria*, order *monogynia*, and arranged in the natural claſſification with thoſe plants the order of which is doubtful. The calyx is four-leaved, the corolla has four petals, and the capſule is bilocular and biroſtrated. There are ſix ſpecies, none of which are natives of Britain.

WELD, or WOLD. See RESEDA, BOTANY *Index*, and DYEING.

WELDING HEAT, in ſmithery, a degree of heat given to iron, &c. ſufficient to make the ſurfaces of two pieces incorporate upon being beaten together with a hammer.

WELL, a hole under ground, uſually of a cylindrical figure, and walled with ſtone and mortar: its uſe is to collect the water of the ſtrata around it.

WELL, an apartment formed in the middle of a ſhip's hold to incloſe the pumps, from the bottom to the lower decks. It is uſed as a barrier to preſerve thoſe machines from being damaged by the friction or compreſſion of the materials contained in the hold, and particularly to prevent the entrance of ballaſt, &c. by which the tubes would preſently be chocked, and the pumps rendered incapable of ſervice. By means of this incloſure, the artificers may likewiſe more readily deſcend into the hold, in order to examine the ſtate of the pumps, and repair them as occaſion requires.

WELL-Room of a Boat, the place in the bottom where the water lies between the ceiling and the platform of the ſtern-ſheets, whence it is thrown out into the ſea with a ſcoop.

Burning-WELL. See *BURNING-Spring*.

WELL of a Fiſhing-veſſel, an apartment in the middle of the hold, which is entirely detached from the reſt, being lined with lead on every ſide, and having the bottom thereof penetrated with a competent number of ſmall holes paſſing alſo through the ſhip's floor; ſo that the ſalt-water running into the well is always kept as freſh as that in the ſea, and yet prevented from communicating itſelf to the other parts of the hold.

WELL-hole, in building, is the hole left in a floor for the ſtairs to come up through.

WELLS, a city of Somerſetſhire, and ſee of a biſhop; the biſhop of Bath being alſo that of Wells.—It is ſuppoſed to take its name from the many ſprings and wells that are near it. It is not very large; but is adorned with handſome buildings, both public and private. Its cathedral is a very beautiful ſtructure, adorned with images and carved ſtone work. The biſhop's palace joins to the cathedral; and on the other ſide are the houſes for the prebendaries. In the market place is a fine market houſe, ſupported by pillars. It is governed by a mayor, and ſends two members to parliament. The chief manufacture is knit hoſe. W. Long. 2. 37. N. Lat. 51. 12.

WEN, a tumor or excreſcence ariſing on different parts of the body, and containing a cyſtus or bag filled with ſome peculiar kind of matter. See NÆVUS, SURGERY *Index*.

WEREGILD, the price of *homicide*; paid partly to the king for the loſs of a ſubject, partly to the lord whoſe vaſſal he was, and partly to the next of kin of the perſon ſlain.

WERST, WURST, or *Verſt*, a Ruſſian meaſure equal to 3500 Engliſh feet. A degree of a great circle of the earth contains about 104 werſts and a half.

WERTURIAN or *URALIAN Mountains*, a famous chain of mountains forming part of the boundary of Aſia. It begins diſtinctly (for it may be traced interuptedly farther ſouth) near the town of Kungur, in the government of Kaſan, in latitude 57° 20′; runs north, and ends oppoſite to the Waygatz ſtrait, and riſes again in the iſle of *Nova Zemlja*. The Ruſſians alſo call this range *Semennoi Poias*, or, *the girdle of the world*; from a ſuppoſition that it encircled the univerſe. Theſe were the *Riphæi montes: Pars mundi damnata a natura rerum, et denſa merſa caligine*[*]; of which only the ſouthern part was known to the ancients, and that ſo little as to give riſe to numberleſs fables. Beyond theſe were placed the happy *Hyperborei*, a fiction moſt beautifully related by Pomponius Mela. Moderns have not been behind-hand in exaggerating ſeveral circumſtances relative to theſe noted hills. Yſbrand Ides, who croſſed them in his embaſſy to China, aſſerts that they are 5000 toiſes or fathoms high; others, that they are covered with eternal ſnow. The laſt may be true in their more northern parts; but in the uſual paſſages over them, they are free from it three or four months.

The heights of part of this chain have been taken by M. l'Abbé d'Auteroche: who, with many aſſurances of his accuracy, ſays, that the height of the mountain Kyria near Solikamſkaia, in latitude 60°, does not exceed 471 toiſes from the level of the ſea, or 286 from the ground on which it ſtands. But, according to M. Gmelin, the mountain Pauda is much higher, being 752 toiſes above the ſea. From Peterſburgh to this chain is a vaſt plain, mixed with certain elevations or platforms, like iſlands in the midſt of an ocean. The eaſtern ſide deſcends gradually to a great diſtance into the wooded and moraſſy Siberia, which forms an immenſe

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[*] Plinii Hiſt. Nat. lib. iv. cap. 12.

Werturian, Weſley.

menſe inclined plane to the Icy ſea. This is evident from all the great rivers taking their riſe on that ſide, ſome at the amazing diſtance of latitude 46°; and, after a courſe of above 27 degrees, falling into the Frozen ocean, in latitude 73° 30′. The Yalik alone, which riſes near the ſouthern part of the eaſtern ſide, takes a ſouthern direction, and drops into the Caſpian ſea. The Dwina, the Peczora, and a few other rivers in European Ruſſia, ſhew the inclined plane of that part. All of them run to the northern ſea; but their courſe is comparatively ſhort. Another inclination directs the Dnieper and the Don into the Euxine, and the vaſt Wolga into the Caſpian ſea.

WESLEY, John, a very extraordinary character, and founder of the ſect of Methodiſts, was the ſon of the Reverend Samuel Weſley, rector of Epworth in the iſle of Axholme in Lincolnſhire, and was born in that village in the year 1703. His very infancy was diſtinguiſhed by an extraordinary incident; for when he was only ſix years old, the parſonage-houſe at Epworth was burnt to the ground, and the flames had ſpread with ſuch rapidity, that few things of value could be ſaved. His mother, in a letter to her ſon Samuel Weſley, then on the foundation at Weſtminſter ſchool, thanks God that no lives were loſt, although for ſome time they gave up *Poor Jacky*, as ſhe expreſſes herſelf; for his father had twice attempted to reſcue the child, but was beaten back by the flames. Finding all his efforts ineffectual, he reſigned him to Divine Providence. But parental tenderneſs prevailed over human fears, and Mr Weſley once more attempted to ſave his child. By ſome means equally unexpected and unaccountable, the boy got round to a window in the front of the houſe, and was taken out, by one man's leaping on the ſhoulders of another, and thus getting within his reach. Immediately on his reſcue from this very perilous ſituation, the roof fell in. This extraordinary eſcape explains a certain device, in a print of Mr John Weſley, engraved by Vertue, in the year 1745, from a painting by Williams. It repreſents a houſe in flames, with this motto from the prophet, "Is he not a brand plucked out of the burning?" Many have ſuppoſed this device to be merely emblematical of his ſpiritual deliverance; but from this circumſtance it is apparent that it has a primary as well as a ſecondary meaning; it is real as well as alluſive.

In the year 1713 he was entered a ſcholar at the charter-houſe in London, where he continued ſeven years under the tuition of the celebrated Dr Walker, and of the Rev. Andrew Tooke author of The Pantheon. Being elected to Lincoln college, Oxford, he became a fellow of that college about the year 1725, took the degree of Maſter of Arts in 1726, and was joint tutor with the Rev. Dr Hutchins the rector. He diſcovered very early an elegant turn for poetry. Some of his gayer poetical effuſions are proofs of a lively fancy and a fine claſſical taſte; and ſome tranſlations from the Latin poets, while at college, are allowed to have great merit. He had early a ſtrong impreſſion, like Count Zinzendorf, of his deſignation to ſome extraordinary work. This impreſſion received additional force from ſome domeſtic incidents; all which his active fancy turned to his own account. His wonderful preſervation, already noticed, naturally tended to cheriſh the idea of his being deſigned by Providence to accompliſh ſome purpoſe or other, that was out of the ordinary courſe of human events. The late Rev. Samuel Badcock, in a letter inſerted in the Bibliotheca Topographica Britannica, N° XX. ſays, "There were ſome ſtrange phenomena perceived at the parſonage at Epworth, and ſome uncommon noiſes heard there from time to time, which he was very curious in examining into, and very particular in relating. I have little doubt that he conſidered himſelf the chief object of this wonderful viſitation. Indeed his father's credulity was in ſome degree affected by it; ſince he collected all the evidences that tended to confirm the ſtory, arranged them with ſcrupulous exactneſs, in a manuſcript conſiſting of ſeveral ſheets, and which is ſtill in being. I know not what became of the ghoſt of Epworth; unleſs, conſidered as the prelude to the noiſe of Mr John Weſley made on a more ample ſtage, it ceaſed to ſpeak when he began to act."

Weſley.

"The dawn of Mr Weſley's public miſſion (continues Mr Badcock) was clouded with myſticiſm; that ſpecies of it which affects ſilence and ſolitude; a certain inexplicable introverſion of the mind, which abſtracts the paſſions from all ſenſible objects; and, as the French Quietiſts expreſs it, perfects itſelf by an abſorption of the will and intellect, and all the faculties, into the Deity." In this *palpable obſcure* the excellent Fenelon led himſelf, when he forſook the ſhades of Pindus, to wander in queſt of *pure love* with Madam Guyon! Mr Weſley purſued for a while the ſame *ignis fatuus* with Mr William Law and the Ghoſt of De Renty. A ſtate, however, ſo torpid and ignoble, ill-ſuited the active genius of this ſingular man. His elaſtic mind gained ſtrength by compreſſion; thence burſting glorious, he paſſed (as he himſelf ſomewhere ſays) "the immenſe chaſm, upborne on an eagle's wings."

The reading of the writings of this Mr William Law, the celebrated author of Chriſtian Perfection, and of A Serious Addreſs to the Chriſtian World, contributed moreover, to lead Mr John Weſley and his brother Charles, with a few of their young fellow-ſtudents, into a more than common ſtrictneſs of religious life. They received the ſacrament of the Lord's Supper every week; obſerved all the faſts of the church; viſited the priſons; roſe at four in the morning; and refrained from all amuſements. From the exact method in which they diſpoſed of every hour, they acquired the appellation of *Methodiſts*; by which their followers have been ever ſince diſtinguiſhed.

But a more particular account of the origin of this ſect, we ſhall give from a celebrated publication. "The Methodiſts (ſays the editor of this work) form a very conſiderable claſs, principally of the lower people in this country. They ſprung up about fifty years ago at Oxford, and were ſoon divided into two parties; the one under the direction of Mr George Whitefield, and the other under that of two brothers, John and Charles Weſley. Theſe leaders, and, if we except Mr William Law, founders of the Methodiſts, were educated at Oxford, received epiſcopal ordination, and always profeſſed themſelves advocates for the articles and liturgy of the eſtabliſhed church; though they more commonly practiſed the diſſenting mode of worſhip. But conceiving a deſign of forming ſeparate communities, ſuperior in ſanctity and perfection to all other Chriſtian churches, and impreſſed to a very conſiderable degree by a zeal of an extravagant and enthuſiaſtic kind, they became itinerant preachers; and, being excluded from moſt of our churches, exerciſed their miniſtry in private houſes, fields,

fields, &c. not only in Great Britain and Ireland, but alſo in America; thus collecting a very conſiderable number of hearers and proſelytes, both among the members of the eſtabliſhed church and the diſſenters. The theological ſyſtem of Mr Whitefield and his followers is Calviniſtic; that of Mr Weſley and his diſciples Arminian; and the latter maintains the poſſibility of attaining ſinleſs perfection in the preſent ſtate. The ſubordinate teachers of both theſe claſſes of Methodiſts are generally men of no liberal education; and they pretend to derive their miniſterial abilities from ſpecial communications of the Spirit. The Methodiſts of both parties, like other enthuſiaſts, make true religion to conſiſt principally in certain affections and inward feelings which it is impoſſible to explain; but which, when analyſed, ſeem to be mechanical in their ſpring and operation; and they generally maintain, that Chriſtians will be moſt likely to ſucceed in the purſuit of truth, not by the dictates of reaſon, or the aids of learning, but by laying their minds open to the direction and influence of divine illumination; and their conduct has been directed by impulſes."

Our readers will judge for themſelves, according to their various modes of education, and to the different lights in which they may reſpectively view the doctrines of our common Chriſtianity, whether this repreſentation of the origin of the Methodiſts, and of their diſtinguiſhing tenets, be accurate and juſt.—Not preſuming to ſit in judgement on the religious opinions of any man, we ſhall only obſerve, that an appellation originally given in reproach, has been gloried in ever ſince by thoſe who have diſtinguiſhed themſelves as the followers either of Mr Whitefield or of Mr Weſley. "After the way called *Methodiſm*, ſo worſhip they the God of their fathers." But the ridicule and contempt which the ſingularity of their conduct produced, both John and Charles Weſley were well qualified to bear. They were not to be intimidated by danger, actuated by intereſt, or deterred by diſgrace.

The boundaries of this iſland were ſoon deemed by Mr Weſley too confined for a zeal which diſplayed the piety of an apoſtle, and of an intrepidity to which few miſſionaries had been ſuperior. In 1735 he embarked for Georgia, one of our colonies, which was at that time in a ſtate of political infancy; and the great object of this voyage was to preach the goſpel to the Indian nations in the vicinity of that province. He returned to England in 1737. Of his ſpiritual labours, both in this country and in America, he himſelf has given a very copious account, in a ſeries of Journals printed at different periods. Theſe journals drew upon our laborious preacher and his coadjutors ſome ſevere animadverſions from two right reverend prelates; Dr George Lavington biſhop of Exeter, and Dr William Warburton biſhop of Glouceſter. The former publiſhed, in three parts, The Enthuſiaſm of the Methodiſts and Papiſts compared; the third part of this performance containing a perſonal charge of immoral conduct. Mr Weſley, in his vindication, publiſhed a letter to his lordſhip, which produced a reply from the latter.

Biſhop Warburton's attack is contained in his celebrated treatiſe, entitled The Doctrine of Grace: or, The Office and Operations of the Holy Spirit vindicated from the Inſults of Infidelity, and the Abuſes of Fanaticiſm: concluding with ſome thoughts, humbly offered to the conſideration of the Eſtabliſhed Clergy, with regard to the Right Method of defending Religion againſt the Attacks of either party; 2 vols. ſmall 8vo, 1762. There is much acute reaſoning, and much poignant and ſprightly wit, in his Doctrine of Grace; but there is too much levity in it for a grave biſhop, and too much abuſe for a candid Chriſtian. On this occaſion, Mr Weſley publiſhed a letter to the biſhop, in which, with great temper and moderation, as well as with great ingenuity and addreſs, he endeavoured to ſhelter himſelf from his lordſhip's attacks; not only under the authority of the Holy Scriptures, but of the church itſelf, as by law eſtabliſhed.

On his return from Georgia, Mr Weſley paid a viſit to Count Zinzendorf, the celebrated founder of the ſect of Moravians, or Hernhutters, at Hernhut in Upper Luſatia. In the following year he appeared again in England, and with his brother Charles, at the head of the Methodiſts. He preached his firſt field-ſermon at Briſtol, on the 2d of April 1738; from which time his diſciples have continued to increaſe. In 1741, a ſerious altercation took place between him and Mr Whitefield. In 1744, attempting to preach at an inn at Taunton, he was regularly ſilenced by the magiſtrates. Although he chiefly reſided for the remainder of his life in the metropolis, he occaſionally travelled through every part of Great Britain and Ireland, eſtabliſhing congregations in each kingdom. In 1750 he married a lady, from whom he was afterwards ſeparated. By this lady, who died in 1781, he had no children.

We have already mentioned Mr Weſley as a very various and voluminous writer. Divinity, both devotional and controverſial, biography, hiſtory, philoſophy, politics, and poetry, were all, at different times, the ſubjects of his pen: and, whatever opinion may be entertained of his theological ſentiments, it is impoſſible to deny him the merit of having done very extenſive good among the lower claſſes of people. He certainly poſſeſſed great abilities, and a fluency which was well accommodated to his hearers, and highly acceptable to them. He had been gradually declining for three years before his death; yet he ſtill roſe at four in the morning, and preached, and travelled, and wrote as uſual. He preached at Leatherhead, in Surrey, on the Wedneſday before that event. On the Friday following, appeared the firſt ſymptoms of his approaching diſſolution. The four ſucceeding days he ſpent in praiſing God; and he left this ſcene, in which his labours had been ſo extenſive and ſo uſeful, at a quarter before ten in the morning of the 2d of March 1791, in the 88th year of his age. His remains, after lying in a kind of ſtate at his chapel in the city-road, dreſſed in the ſacerdotal robes which he uſually wore, and on his head the old clerical cap, a bible in one hand, and a white handkerchief in the other, were, agreeably to his own directions, and after the manner of the interment of the late Mr Whitefield, depoſited in the cemetry behind his chapel, on the morning of the 9th March, amid an innumerable concourſe of his friends and admirers; many of whom appeared in deep mourning on the occaſion. One ſingularity was obſervable in the funeral ſervice. Inſtead of, "We give thee hearty thanks, for that it hath pleaſed thee to deliver this our brother;" it was read "our father." A ſermon, previouſly to the funeral, had been preached by Dr Thomas Whitehead, one of the phyſicians to the

London hoſpital; and on the 13th the different chapels of his perſuaſion in London were hung with black.

It has been juſtly obſerved of Mr Weſley, that his labours were principally devoted to thoſe who had no inſtructor; to the highways and hedges; to the miners in Cornwall, and the coalliers in Kingſwood. Theſe unhappy creatures married and buried among themſelves, and often committed murders with impunity, before the Methodiſts ſprung up. By the humane and active endeavours of Mr Weſley and his brother Charles, a ſenſe of decency, morals, and religion, was introduced into the loweſt claſſes of mankind; the ignorant were inſtructed, the wretched relieved, and the abandoned reclaimed. His perſonal influence was greater, perhaps, than that of any other private gentleman in any country.—But the limits of this article will not permit us to expatiate further on the character of this extraordinary man.

WEST, Gilbert, was the ſon of Dr Weſt, prebendary of Wincheſter, and chaplain to King George I. but at 12 years of age loſt his father. He ſtudied at Wincheſter and Eton ſchools, and from thence was placed in Chriſt-church college, Oxford. His ſtudious and ſerious turn inclined him to take orders; but Lord Cobham, his uncle, diverted him from that purſuit, and gave him a cornetcy in his own regiment. This profeſſion he ſoon quitted, on account of an opening of another nature, which preſented him with a flattering proſpect of advancement in life. A number of young gentlemen were to be elected from the univerſities, and, at the expence of government, were to be taught foreign languages; and then ſent to the ſecretaries office, to be initiated into buſineſs, and trained there for public ſervices, as envoys, ambaſſadors, &c. Mr Gilbert Weſt was one of the few pitched upon; and on his firſt introduction into that office, Lord Townſend, ſecretary of ſtate, treated him with ſingular marks of regard, and the ſtrongeſt inclinations to ſerve him were teſtified from all quarters. But his uncle Lord Cobham's ſtrong oppoſition to the meaſures of the government, rendered theſe advantages entirely fruitleſs; and the miniſters honeſtly told Mr Weſt, that he muſt not expect them to diſtinguiſh his merit, as any favours conferred upon him would be imputed as done to his uncle Lord Cobham. Mr Weſt now left that office, and all his views of making his fortune; and entering into marriage, retired to Wickham in Kent, where he lived in great domeſtic comfort and tranquil happineſs. He was there viſited by his valuable friends, who held the moſt delightful converſe of wit, humour, and learning, ſupported upon the principles of virtue, ſound reaſoning, and ſolid friendſhip, which rendered the whole cheerful, animating, and inſtructive. Mr William Pitt, who was one of thoſe that compoſed this happy ſociety, becoming paymaſter, appointed Mr Weſt treaſurer to Chelſea-hoſpital; and he obtained a ſeat at the council-board, in conſequence of a friendſhip contracted at the ſchool with one of the duke of Devonſhire's ſons, who procured of his grace his being nominated one of the clerks extraordinary of that office. Towards the latter part of Mr Weſt's life, he wholly applied himſelf to the ſtudy of the Scriptures; being extremely anxious to try his utmoſt endeavours to reconcile the ſeeming inconſiſtencies which gave the enemies to revealed religion a handle to doubt and diſcredit their authenticity. His obſervations on the reſurrection, which, it has been ſaid, were written to confirm the wavering faith of his great friends Pitt and Lyttleton, bear ample teſtimony to his reaſoning powers and the ſincerity of his religion; while his tranſlations of Pindar ſhow him to have been an eminent Greek ſcholar, and very conſiderable poet. He had a mind replete with virtue, and was an honour to his country; but died at 50 years of age.

West, one of the cardinal points of the horizon, diametrically oppoſite to the eaſt; and ſtrictly defined the interſection of the prime vertical with the horizon on that ſide the ſun ſets in.

WESTMINSTER, a city which forms the weſt part of the capital of Britain, but has a government diſtinct from the reſt. This city had its name from the ſituation of its abbey, anciently called a *minſter*, in reſpect of that of St Paul. That part properly called the city of Weſtminſter, comprehending the pariſhes of St John and St Margaret, was once an iſland formed by the Thames, called *Thorney iſland*, from the thorns with which it was overrun; and the abbey that ſtood in it, Thorney-abbey. The liberties of Weſtminſter contain the ſeveral pariſhes of St Martin in the Fields, St James's, St Anne, St Paul, Covent-Garden, St Mary le Strand, St Clement Danes, St George, Hanover Square, and the precinct of the Savoy. The government, both of the city and liberties, is under the juriſdiction of the dean and chapter of Weſtminſter, in civil as well as eccleſiaſtical affairs; and their authority extends to the precinct of St Martin le Grand, by Newgate-ſtreet, and in ſome towns of Eſſex, which are exempted from the juriſdiction of the biſhop of London and the archbiſhop of Canterbury; but the management of the civil part has, ever ſince the Reformation, been in the hands of laymen, elected from time to time, and confirmed by the dean and chapter. The chief of theſe laymen are the high-ſteward, the deputy-ſteward, and the high-bailiff, who hold their offices for life. There are alſo 16 burgeſſes and their aſſiſtants, out of which are elected two head-burgeſſes, one for the city, and the other for the liberties. Another officer is the high-conſtable, who has all the other conſtables under his direction.

WESTMORELAND, a county of England, bounded on the north and north-weſt by Cumberland; on the ſouth and ſouth-eaſt by Yorkſhire; and on the ſouth and ſouth-weſt by Lancaſhire. Its extent from north-eaſt to ſouth, is 40 miles, and its breadth from the eaſt projection to that in the weſt, 42. It is generally divided into the baronies of Kendal and Weſtmoreland: the former is very mountainous, but the latter is a large champaign country. Theſe are the only principal diviſions of this county, which contains eight market towns, 26 pariſhes, and 41,617 inhabitants. It lies partly in the dioceſe of Cheſter, and partly in that of Carliſle. The earl of Thanet is hereditary ſheriff of the county, which ſends only four members to parliament. The air is clear, ſharp, and ſalubrious, the natives being ſeldom troubled with diſeaſes, and generally living to old age. The ſoil is various; that on the mountains is very barren, while that in the valleys is fertile, producing good corn and graſs, eſpecially in the meadows near the rivers. In the hilly parts on the weſtern borders it is generally believed there are vaſt quantities of copper ore, and veins of gold; ſome mines of copper are worked, but moſt of the ore lies ſo deep that it will not anſwer the

the expence. This county yields the fineſt ſlate, and abundance of excellent hams are cured here. The principal rivers are, the Eden, the Lone, and the Ken. It has alſo ſeveral fine lakes, the principal of which is Winander Mere, or Windermere water. In the foreſt of Martindale, to the ſouth of Ulls-water, the breed of red deer ſtill exiſts in a wild ſtate.—Appleby is the county town.

WESTPHALIA, formerly a duchy of Germany, bounded to the eaſt by the biſhopric of Paderborn, and the territories of Waldeck and Heſſe; to the ſouth by the counties of Witgenſtein and Naſſau, and the duchy of Berg; to the north by the biſhopric of Munſter and the county of Lippe. It is about 40 miles in length and 30 in breadth. The lower part of it is very fruitful, yielding plenty of corn and cattle, and ſome ſalt ſprings. The higher affords iron ore, calamine, lead, copper, ſome ſilver and gold, fine woods, cattle, game, fiſh, with a little corn. The rivers, that either paſs through the duchy or along its borders, are the Rahr, the Lenne, the Bigge, the Dimel, and the Lippe. There are 28 towns in it, beſides boroughs and cloiſters. The provincial diets are held at Arenſberg. In the year 1180, the emperor Fred. I. made a donation of this duchy to the archbiſhopric of Cologne, which was confirmed by ſucceeding emperors; and in 1638, the laſt duke of Arenſberg ceded to it alſo the county of Arensberg.

Westphalia, one of the circles of Germany, anciently the people inhabiting between the Weſer and the Rhine, were called *Weſtphalians*; and hence that tract got the name of *Weſtphalia*: but the circle of that name is of a larger extent, being ſurrounded by the circle of Burgundy, or the Auſtrian Netherlands, the United Provinces, and the North ſea, with the circles of the Upper and Lower Rhine, and compriſing a great many different ſtates.

The ſummoning princes and directors of the circle of Weſtphalia, were the biſhops of Munſter, alternately with the electors of Brandenburg and Palatine, as dukes of Cleve and Juliers. The archives belonging to it were before the war (1797) kept at Duſſeldorp. Its quota of men and money is ſomewhat more than the ninth part of the whole ſum granted by the empire. With reſpect to religion, it is partly Proteſtant and partly Catholic; but the Proteſtants predominate, and are, at leaſt the greater part of them, Calviniſts. The air of this country is not reckoned very wholeſome, and towards the north is extremely cold in winter. The ſoil in general is marſhy and barren; yet there is ſome good corn and paſture land; but the fruit is chiefly uſed to feed hogs; and hence it is that their bacon and hams are ſo much valued and admired.

Weſtphalia now forms one of the kingdoms eſtabliſhed by Bonaparte.

WESTRINGIA, a genus of plants, formed from *cunila fruticoſa*, which was diſcovered by Dr Solander in New Holland. Dr Smith deſcribes it as approaching nearer to roſemary, and places it after *teucrium* in the claſs didynamia.

WET-couch, *Coming-heap*, a term uſed by the maltſters for one of the principal articles of malt-making. See Brewing, N° 4.

WETSTEIN, John James, a learned German divine, was born at Baſil in 1693. On his admiſſion to the miniſtry, he maintained a theſis *De variis Novi Teſtamenti Lectionibus*; in which he ſhowed that the great variety of readings of the New Teſtament afford no argument againſt the authenticity of the text. He had made theſe various readings the object of his attention; and travelled into foreign countries to examine all the MSS. he could come at. In 1730, he publiſhed *Prolegomena ad Novi Teſtamenti Græci editionem accuratiſſimam, &c.* Some divines, dreading his unſettling the preſent text, procured a decree of the ſenate of Baſil againſt his undertaking, and even got him prohibited from officiating in the miniſtry; on which he went to Amſterdam, where the Remonſtrants named him to ſucceed the famous Le Clerc, then ſuperannuated, as profeſſor of philoſophy and hiſtory. At laſt he publiſhed his edition of the New Teſtament, in 2 vols. folio, 1752; in which he left the text as he found it, placing the various readings, with a critical commentary, underneath; ſubjoining two epiſtles of Clemens Romanus, till then unknown to the learned, but diſcovered by him in a Syriac MS. of the New Teſtament. He alſo publiſhed ſome ſmall works; and is ſaid to have been not only an univerſal ſcholar, but to have abounded in good and amiable qualities. He died at Amſterdam in 1754.

WETTERAVIA, the ſouthern diviſion of the landgravate of Heſſe in Germany, lying along the northern bank of the river Maine, and comprehending the counties of Hanau and Naſſau.

WEXFORD, a county of Ireland, in the province of Munſter, 38 miles in length, and 24 in breadth; bounded on the north by Wicklow, on the eaſt by St George's channel, on the ſouth by the Atlantic ocean, on the weſt by Waterford and Kilkenny, and on the north by Catherlough. It contains 109 pariſhes, and formerly ſent 18 members to the Iriſh parliament. It is a fruitful country in corn and graſs; and the principal town is of the ſame name.

Wexford, a ſea-port of Ireland, capital of a county of the ſame name. It was once reckoned the chief city in Ireland, being the firſt colony of the Engliſh, and is ſtill a large handſome town, with a very commodious harbour at the mouth of the river Slana, on a bay of St George's channel, 63 miles ſouth of Dublin. W. Long. 6. 3. N. Lat. 52. 18.

WHALE. See Balæna and Physeter, Cetology *Index*.

Whale, one of the conſtellations. See Astronomy.

Whale-Bone. For its natural hiſtory, ſee Cetology *Index*.

A patent was granted in October 1806 to Robert Bowman of Leith, in Scotland, for making hats, caps, and bonnets for men and women, of whalebone; harps for harping or cleanſing corn or grain; and alſo the bottoms of ſieves and riddles, and girths for horſes; and alſo a cloth or webbing for making into hats, caps, &c.; and for the backs and ſeats of chairs and ſofas, gigs, coaches, and other ſimilar carriages; and the bottoms of beds; as alſo reeds for weavers.

Whale-Fiſhery. See Cetology.

WHARF, a ſpace on the banks of a haven, creek, or hithe, provided for the convenient loading and unloading of veſſels.

WHARTON, Philip duke of, a nobleman of the moſt brilliant parts, but of the moſt whimſical, extravagant, and inconſiſtent turn of mind, was educated by his

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father's expreſs order at home. He very early married a young lady, the daughter of Major-General Holmes, which diſappointed his father's views of diſpoſing of him in ſuch a marriage as would have been a conſiderable addition to the fortune and grandeur of his illuſtrious family; yet that amiable lady deſerved infinitely more felicity than ſhe met with by this alliance. This precipitate marriage is thought to have haſtened the death of his father; after which the duke, being free from paternal reſtraints, plunged into thoſe exceſſes which rendered him, as Pope expreſſes it,

> " A tyrant to the wife his heart approv'd;
> " A rebel to the very king he lov'd."

In the beginning of the year 1716, he began his travels; and as he was deſigned to be inſtructed in the ſtricteſt Whig principles, Geneva was thought a proper place for his reſidence, He firſt paſſed through Holland, and viſited ſeveral courts of Germany; and being arrived at Geneva, conceived ſuch a diſguſt againſt his governor, that he left him, and ſet out poſt for Lyons, where he wrote a letter to the chevalier de St George, who then reſided at Avignon, and preſented him a very fine ſtout horſe; which the chevalier no ſooner received than he ſent a man of quality to him, who took him privately to his court, where he was entertained with the greateſt marks of eſteem, and had the title of duke of Northumberland conferred upon him. He, however, remained there but one day, and then returned poſt to Lyons, whence he ſet out for Paris. He likewiſe paid a viſit to the conſort of James II. who then reſided at St Germains, to whom he alſo paid his court. During his ſtay at Paris, his winning addreſs and abilities gained him the eſteem and admiration of all the Britiſh ſubjects of rank of both parties.

About the latter end of December 1716, he arrived in England, whence he ſoon after ſet out for Ireland, where, though under age, he was allowed the honour to take his ſeat in the houſe of peers, and immediately diſtinguiſhed himſelf, notwithſtanding his former conduct, as a violent partizan for the miniſtry; in conſequence of which zeal the king created him a duke. He no ſooner came of age than he was introduced to the houſe of lords in England with the ſame blaze of reputation. In a little time he oppoſed the court, and appeared one of the moſt vigorous in defence of the biſhop of Rocheſter; and ſoon after printed his thoughts twice a-week, in a paper called the *True Briton*, ſeveral thouſands of which were circulated.

The duke's boundleſs profuſion had by this time ſo burdened his eſtate, that by a decree of Chancery it was veſted in the hands of truſtees for the payment of his debts, allowing him a proviſion of 1200l. per annum for his ſubſiſtence. This being inſufficient to ſupport his title with ſuitable dignity, he went abroad and ſhone to great advantage, with reſpect to his perſonal character, at the imperial court. From thence he made a tour to Spain: the Engliſh miniſter was alarmed at his arrival, fearing that his grace was received in the character of an ambaſſador: upon which the duke received a ſummons under the privy-ſeal to return home; but inſtead of obeying it, he endeavoured to inflame the Spaniſh court againſt that of Great Britain, for exerciſing an act of power, as he calls it, within the juriſdiction of his Catholic majeſty. He then acted openly in the ſervice of the Pretender, and was received at his court with the greateſt marks of favour.

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While his grace was thus employed, his neglected ducheſs died in England on the 14th of April 1726, without iſſue. Soon after the duke fell violently in love with M. Oberne, one of the maids of honour to the queen of Spain, the daughter of an Iriſh colonel, whoſe fortune chiefly conſiſted in her perſonal accompliſhments. All his friends, and particularly the queen of Spain, oppoſed the match; but he falling into a lingering fever, occaſioned by his diſappointment, the queen gave her conſent, and they were ſoon after married. He then ſpent ſome time at Rome, where he accepted of a blue garter, aſſumed the title of duke of Northumberland, and for a while enjoyed the confidence of the exiled prince. But not always keeping within the bounds of Italian gravity, it became neceſſary for him to remove from hence; when, going by ſea to Barcelona, he wrote a letter to the king of Spain acquainting him that he would aſſiſt at the ſiege of Gibraltar as a volunteer. Soon after he wrote to the chevalier de St George, expreſſing a deſire to viſit his court; but the chevalier adviſed him to draw near to England.

The duke ſeemed reſolved to follow his advice; and ſetting out with his ducheſs, arrived in Paris in May 1728, whence he ſoon after proceeded to Rouen, where he took up his reſidence; and was ſo far from making any conceſſion to the government of England, that he did not give himſelf the leaſt trouble about his eſtate, or any other concern there; though, on his arrival at Rouen, he had only about 600l. in his poſſeſſion, and a bill of indictment was preferred againſt him in England for high-treaſon. Soon after the chevalier ſent him 2000l. which he ſquandered away in a courſe of extravagance; when, to ſave the charges of travelling by land, he went from Orleans to Nantz by water, and ſtaid there till he got a remittance from Paris, which was ſquandered almoſt as ſoon as received. At Nantz he was joined by his ragged ſervants, and from hence took ſhipping with them for Bilboa, when the queen of Spain took the ducheſs to attend her perſon. About the beginning of the year 1731, the duke, who commanded a regiment, was at Lerida, but declined ſo faſt that he could not move without aſſiſtance; yet when free from pain did not loſe his gaiety. He, however, received benefit from ſome mineral waters in Catalonia; but ſoon after relapſed at a ſmall village, where he was utterly deſtitute of all the neceſſaries of life, till ſome charitable fathers of a Bernardine convent removed him to their houſe, and gave him all the relief in their power. Under their hoſpitable roof he languiſhed a week, and then died, without one friend or acquaintance to cloſe his eyes; and his funeral was performed in the ſame manner in which the fathers inter thoſe of their own fraternity.

Thus died Philip duke of Wharton, " who, like Buckingham and Rocheſter (ſays Mr Walpole), comforted all the grave and dull, by throwing away the brighteſt profuſion of parts on witty fooleries, debaucheries, and ſcrapes, which mix graces with a great character, but never can compoſe one.

" With attachment to no party, though with talents to govern any party, this lively man changed the free air of Weſtminſter for the gloom of the Eſcurial, the proſpect of King George's garter for the Pretender's;

and with indifference to all religion, the frolic lord who had written the ballad on the archbiſhop of Canterbury, died in the habit of a capuchin. It is difficult to give an account of the works of a man whoſe library was a tavern, and women of pleaſure his muſes. A thouſand ſallies of his imagination may have been loſt. There are only two volumes in 8vo, called *his Life and Writings*. Theſe contain nothing of the latter, but 74 numbers of the True Briton, and his ſpeech in defence of the biſhop of Rocheſter. His other works are the ballads above mentioned; the Drinking Match at Eden-hall, in imitation of the Chevy Chace, printed in a miſcellany called *Whartoniana*; and a parody of a ſong ſung at the opera-houſe by Mrs Tofts. His lordſhip alſo began a play on the ſtory of the queen of Scots."

WHEAT. See TRITICUM, BOTANY *Index*; and for the culture of wheat, ſee AGRICULTURE *Index*.

The three principal kinds of bad wheat are, the *blighted*, the *ſmutty*, and the *worm-eaten*. Blighted wheat is that of which the ſtalk is a little twiſted and rickety, the blade being of a bluiſh green and curled up, the grain alſo is green and tubercled: ſmutty wheat appears as if great part of the ear had been burnt, ſome ſmall parts only being free, and, in particular, the ſtem that riſes in the centre of the ear, round which the grain is ranged: worm-eaten or rotten wheat is corrupted without loſing much of its natural form, or external appearance; the huſk is filled with a greaſy black powder, that is inſufferably fetid. It appeared, from the experiments of M. Tillet, that there was a kind of infectious quality in all thoſe kinds of wheat: ſo that if ſound wheat was ſprinkled with the flour of ſmutty or rotten wheat, the crop produced would be rotten or ſmutty. It appeared alſo, that among the grain which was produced from ground manured with the ſtraw of diſtempered wheat, there was a much greater proportion of diſtempered wheat than in that produced from ground manured with the ſtraw of good wheat: the great ſecret then was to deſtroy the principle of this contagion in the wheat that was put into the ground; and M. Tillet found, as the reſult of a great number of experiments, that if the grain, before it is ſowed, be well moiſtened with a ſolution of ſea-ſalt, or nitre, in common water, none of the enſuing crop will be ſmutty, or otherwiſe defective, either in kind or quality; not only ſuppoſing the grain that is ſowed to be ſound, and the ſoil to be good, but even ſuppoſing the grain to be ſtrewed with the flour of ſmutty wheat, and the ground manured with bad ſtraw.

Prize Diſſertation by the Academy of Bourdeaux.

The following receipt for preventing ſmutty wheat was publiſhed in 1769 by order of the Society for the Encouragement of Arts: they received it from Mr John Reynolds of Adiſham in Kent.

A tub is to be procured that has a hole at bottom, in which a ſtaff and tap-hoſe is to be fixed over a whiſp of ſtraw, to prevent any ſmall pieces of lime paſſing (as in the brewing way); this done, we put 70 gallons of water, then a corn buſhel heap-full of ſtone-lime, unſlaked, ſtirring it well till the whole is diſſolved or mixed, letting it ſtand about 30 hours, and then run it off into another tub as clear as we can (as practiſed in beer): this generally produces a hogſhead of good ſtrong lime-water; then add three pecks of ſalt, 42 pounds, which, with a little ſtirring, will ſoon diſſolve; thus we have a proper pickle for the purpoſe of brining and liming our ſeed-wheat without any manner of obſtacle, which is more than can be ſaid in doing it the common way, and greatly facilitates the drilling.

Herein we ſteep the wheat in a broad-bottomed baſket of about 24 inches diameter, and 20 inches deep (for large ſowing, made on purpoſe), running in the grain gradually in ſmall quantities from 10 to 12 gallons up to 16 gallons, ſtirring the ſame. What floats, we ſkim off with a ſtrainer, and is not to be ſown: then draw up the baſket to drain over the pickle, for a few minutes; all which may be performed within half an hour, ſufficiently pickled; and ſo proceed as before. This done, the wheat will be fit for ſowing in 24 hours, if required; but if deſigned for drilling, two hours pickled will be found beſt; and if prepared four or five days beforehand, in either caſe it makes no difference at all; but ſhould the ſeed be clammy, and ſtick to the notches in the drill-box, more lime muſt be added to the lime-water; here the maſter muſt uſe his diſcretion, as the caſe requires; for ſome lime has much more drying or aſtringent qualities in it than others. If ſea-water can be obtained conveniently, much leſs ſalt will ſuffice, but ſome will be found neceſſary even then, otherwiſe the light grains will not float, a thing of more conſequence than is generally imagined, and it ought to be ſkimmed off and thrown aſide for poultry, &c.

WHEEL, in *Mechanics*, a ſimple machine, conſiſting of a round piece of wood, metal, or other matter, which revolves on its axis. See MECHANICS.

WHEEL-Carriages. See MECHANICS for an account of the general principles.

No kind of wheel-carriages are of more importance to a commercial and manufacturing country than ſtage coaches; and perhaps in no kingdom of Europe has the ſyſtem of travelling in public vehicles been carried to greater perfection, as to comfort and ſpeed, than in Britain. The danger, however, of travelling by theſe coaches makes conſiderable deduction from their accommodation otherwiſe: it is but too well known that this mode of travelling is liable to frequent and ſerious accidents. Every attempt therefore that promiſes to be uſeful in diminiſhing ſuch danger ſhould have all poſſible publicity. With this view we are much gratified in having an opportunity of laying before our readers the following account of an invention to render ſtage coaches more ſecure from danger, obligingly tranſmitted to us by the inventor, the reverend William Milton of Heckfield, Hants. For this invention that gentleman has obtained a patent.

The danger of ſtage coaches ariſes ſometimes from *overturning*, and ſometimes from *breaking down*. The *overturn* is, in general, occaſioned *either* by taking two ſide-wheels into too deep a hole or ditch, or over too high a bank; *or*, ſecondly, by running down more quickly than the carriage is calculated to do, from the top to the ſides of a rounded road; *or*, laſtly, by turning a ſharp corner with too great velocity. In the two firſt caſes the danger ariſes from the centre of gravity of the total coach and load being placed too high; and in the laſt inſtance, of turning the ſharp corner, from the ſame centre (but which we muſt now conſider as the centre of the *vis inertiæ*) being alſo placed too high. The danger in the two firſt caſes grows often out of the very circumſtances of the road, and meets every one's comprehenſion: the laſt, which is leſs obvious, is generally owing to the mere will of the driver; and the better the road, the more is he tempted, without any intention, to go on to produce it: it requires therefore to be more generally underſtood than it is. It may be thus explained:—A carriage is going along a ſtraight level road at the rate of nine miles an hour: then, though you imagine the horſes or pulling power to be in an inſtant withdrawn, yet will the carriage continue its motion for ten, fifteen, or more yards, and at firſt with the ſame velocity, *and in the ſame ſtraight line, in conſequence of the acquired motion.* Suppoſing, now, the coach with its four horſes going the nine miles an hour along a fine level road, but which has *a ſharp and ſudden corner to turn;*—the coachman knows it, and wiſhes to keep his velocity; the horſes are aware of both—and by the animal dexterity with which they are gifted, *contrive to make the turn* without remitting any thing of their ſpeed. *Not ſo the coach which follows them;* that has a tendency to perſevere *in its ſtraight line;* and the centre of its effort to do ſo is the centre of its *vis inertiæ*, the very centre of its gravity. If this centre be *low*, the turn of the corner may be made with no other inconvenience than a ſhort awkward ſlide of the hind wheels, *onward in the original direction*; whereas, if it *be high*, there will be no ſlide, but *the coach will be overturned*, and overturned nearly at that point where its broadſide is at rectangles to the ſtraight line of road it has been thus forced to quit: for at that point the baſe againſt ſuch an overturn will be the moſt diſadvantageous, and the check to the onward motion the greateſt. The *remedy* offered againſt all theſe *cauſes of the overturn*, (whether by a *ditch*, *bank*, *rounded road*, or *ſharp corner*), *is to bring down this centre*, by placing as much of the luggage as poſſible *in a luggage-box, below the body of the carriage;* the body not being higher than uſual.

From the *overturn*, we paſs to the conſideration of the *breaking-down;* this we muſt reckon on happening as often in theſe patent ſtage coaches as in others. Wheels will come off or fail, or axles will break, *in future, as they have done heretofore;* but againſt the diſaſtrous and fatal conſequences of ſuch accidents the remedy offered may be thus deſcribed.—On each ſide of *the luggage-box*, with their periphery below its floor, and each as near as may be requiſite to its reſpective *active wheel*, there is placed a *ſmall ſtrong idle wheel, ready* in caſe of *breaking down, on either ſide, to catch the falling carriage, and inſtantly to continue its previous velocity*, till the coachman can pull up his horſes, thereby preventing *that ſudden ſtop to rapid motion*, which at preſent conſtantly attends the *breaking-down;* and which has ſo frequently proved fatal to the coachman and outſide paſſengers. In caſe a fore-wheel comes off, each end of the fore-carriage has its *idle wheel.* By this proviſion we ſhall be, *to all effect of ſafety*, continually travelling with two carriages under us. The bottom of this luggage-box is meant to be about fourteen inches from the ground; and the *idle wheels* ſeven, ſix, or five; but if at a ſtill leſs diſtance, little inconvenience would reſult; for when either of them takes over an obſtacle in the road, it inſtantly, and during the need, diſcharges its reſpective *active wheel* from the ground, and works in its ſtead. If theſe two principles of ſafety were applied to the deſcription of the ſeveral ſtage-coach accidents we meet with, there is no doubt but a general conviction would ariſe, *that* the ſafety by theſe modes is (in vehicles of all kinds), perhaps *as great as can conſiſt with rapid loco-motion; and that*, ſooner or later, *legiſlative authority*, in ſome ſhape or other, may judge it neceſſary to interpoſe, for the purpoſe of controlling a prejudice againſt *the form eſſential to this mode of ſafety.* The trial and proof which theſe principles have been brought to, have not only been by public exhibition, and with preparation; but *in all the ſuddenneſs*, alſo, *of actual heavy work:* and the reſult in both caſes has been ſo exactly the ſame, as to give *continual aſſurance* of the full effect of the remedy, as often as the caſualties of the road ſhall bring it into action.

The aim in the arrangement of this *coach of ſafety*, has been to bring down the load, and conſequently the center of gravity, as low as poſſible: this is thought to make the coach *look heavy;* and this word, by the ready operation of a prejudice, has been transferred to its going; and one ſpecific reaſon added withal, that, *becauſe the load is low*, the draught *muſt* be heavy. This point, however, has, in the preſence of 10 or 12 competent perſons, been brought to the moſt deciſive proof; and it comes out, that it is as indifferent to draught, as it is material to danger or ſafety, whether *a ton* be placed on the roof of a coach, or *a ton* on the floor of the patent luggage-box, about 15 or 16 inches from the ground.

It has been aſked, "*What would this coach do in ſnow?*" The queſtion has been thus anſwered by the reſult of actual work; for the patent coach, after being detained on the road with ſeveral other coaches, by a ſudden fall of ſnow, when at laſt they ſtarted together, *came in ſix or ſeven hours before any of them.* They were bound in prudence, to go cautiouſly along the ground, whoſe unevenneſs was inviſible; while the patent coach daſhed along it with all the confidence and ſafety of a poſt-chaiſe. See Plate DLXXVII.

WHEEL-Animal. See ANIMALCULE, N° 16—23.

WHEEL, Perſian. See AGRICULTURE.

WHEEL, Potter's See PORCELAIN.

WHEEL is alſo the name of a kind of puniſhment to which great criminals are put in divers countries. In ſome, aſſaſſins, parricides, and robbers on the highway, are ſaid to be condemned to the wheel, when they are to have their bones firſt broken with an iron bar on a ſcaffold, and then to be expoſed, and left to expire on the circumference of a wheel. In Germany they break their bones on the wheel itſelf.—Of this cruel puniſhment, it is not certain who was the inventor: it was firſt uſed in Germany, and was, indeed, but rarely practiſed anywhere elſe, till the time of Francis I. of France; who, by an edict of the year 1534, appointed it to be inflicted on robbers on the highway.

WHEELER, SIR GEORGE, a learned traveller and divine, was the ſon of Colonel Wheeler of Charing in Kent, and was born in 1650 at Breda, where his parents as royaliſts were then in exile. He travelled through various parts of Greece and the Eaſt, in company with Dr James Spon of Lyons; and taking orders on his return, was inſtalled a prebend of Durham, made vicar of Baſingſtoke; and afterward rector of Houghton le Spring. He publiſhed an account of his Travels in 1682 in folio; and in 1689, his Obſervations on Ancient Edifices of Churches yet remaining in the Eaſt, compared

Fig. 1.

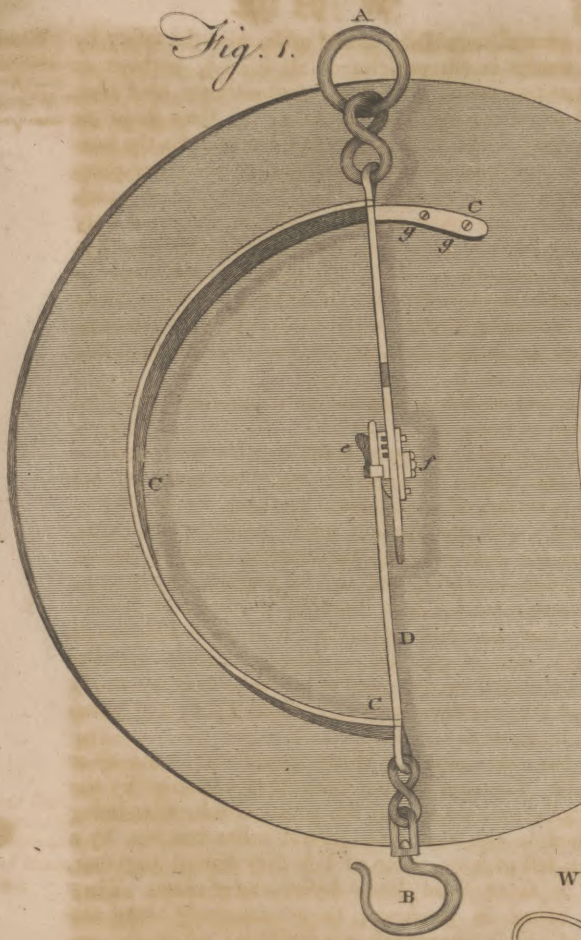
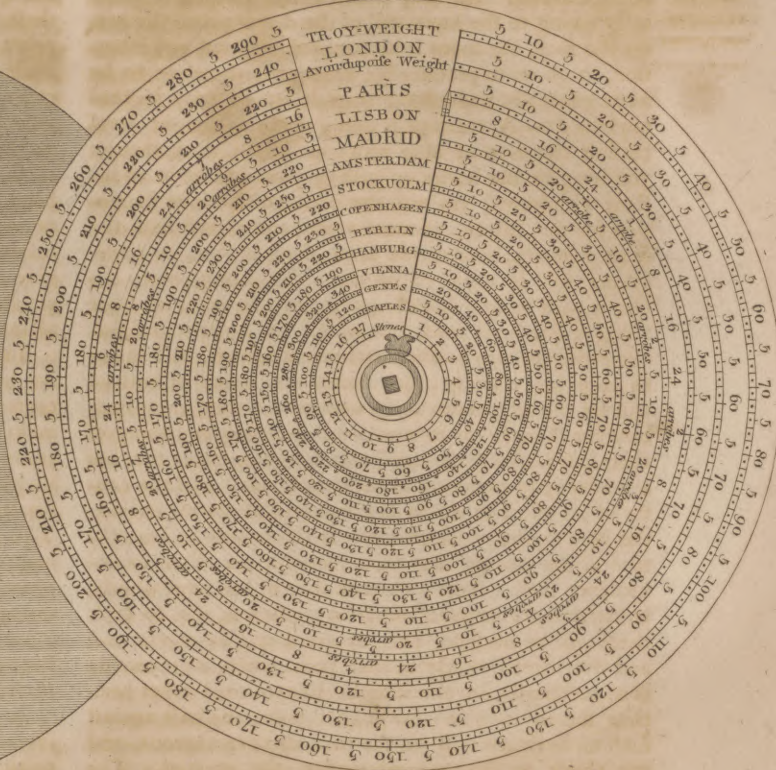
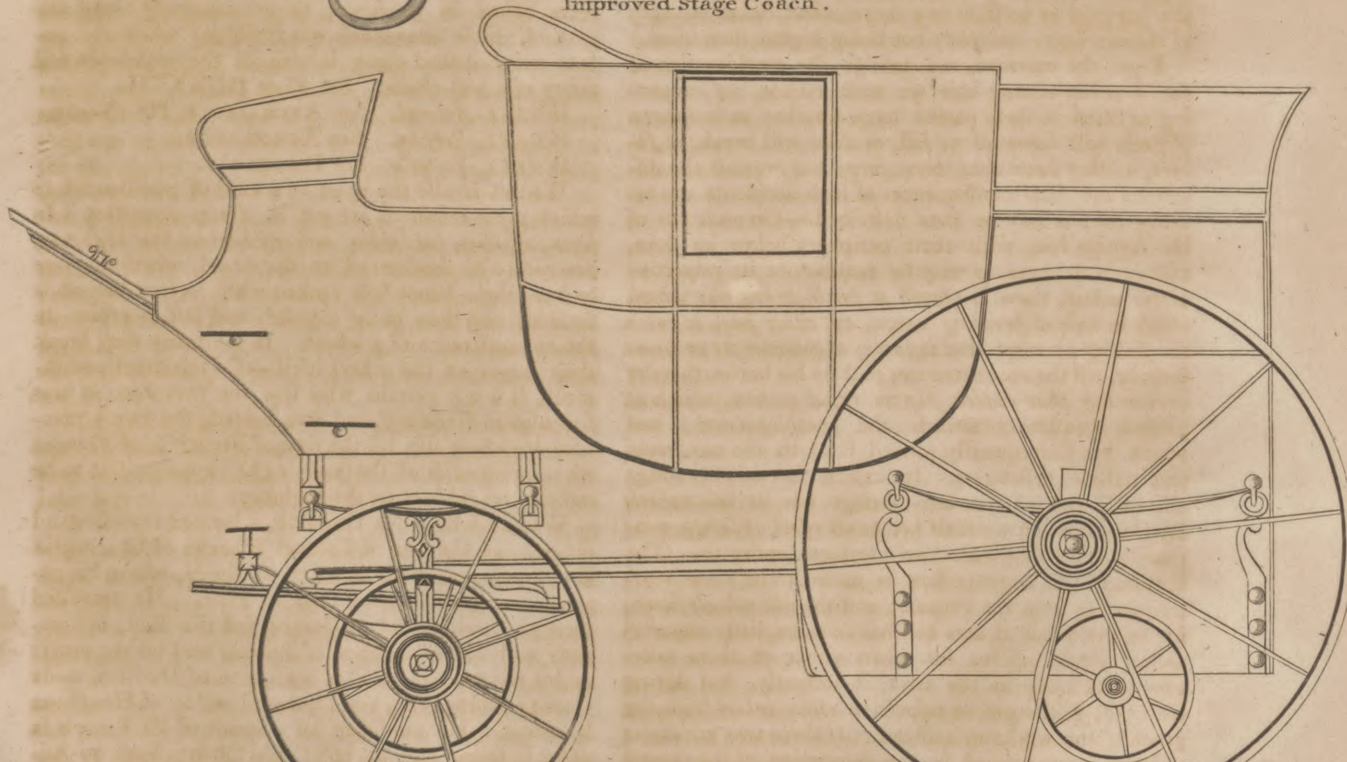


Fig. 2.



WHEEL CARRIAGES

Improved Stage Coach.



W. Train Sculpt.

compared with Euſebius: alſo the Proteſtant Monaſtery, or Chriſtian Oeconomics. He died in 1724.

WHEELINGS, in the military art, are different motions made both by horſe and foot, either to the right and left, or to the right and left about.

General Rules for WHEELING—The circle is divided into four equal points: thence, wheeling to the right or left, is only a quarter of the circle; wheeling to the right or left about, is one half of the circle.

When you wheel to the right, you are to cloſe to the right, ſo near as to touch your right-hand man, but without preſſing him; and to look to the left, in order to bring the rank about even.

When you wheel to the left, you are to cloſe to the left, and look to the right as above directed. This rule will ſerve for all the wheeling by ranks; as when a battalion is marching by ſubdiviſions with their ranks open, then each rank wheels diſtinctly by itſelf, when it comes to the ground on which the ranks before it wheeled, but not before.

In wheeling, the men are to take particular care neither to open nor cloſe their ranks, and to carry their arms well.

In wheeling, the motion of each man is quicker or ſlower, according to the diſtance he is from the right or the left: thus, when you wheel to the right, each man moves quicker than his right-hand man; and wheeling to the left, each man moves quicker than his left-hand man; the circle that every man wheels being larger, according to the diſtance he is from the hand he wheels to; as may be ſeen by deſcribing ſeveral circles within one another, at two feet diſtance from each, which is nearly the ſpace every man is ſuppoſed to take up.

WHELK, a ſpecies of ſhell-fiſh. See BUCCINUM, CONCHOLOGY *Index*.

WHELP, the young of a dog, fox, lion, or any wild beaſt.

WHELPS, in a ſhip, the ſeaman's term for thoſe brackets which are ſet up on the capſtan cloſe under the bars; they give the ſweep to it, and are ſo contrived that the cable winding about them may not ſurge ſo much as it might otherwiſe do if the body of the capſtan were quite round and ſmooth.

WHETSTONE, a ſtone ſo called, becauſe it ſerves for the whetting of edge tools upon. See MINERALOGY *Index*.

WHEY, the ſerum or watery part of milk.

WHIDAH, a kingdom of Africa, on the coaſt of Guinea, and to the weſt of the Gold Coaſt; extending about 10 miles along the ſea. It is a populous country, well furniſhed with large villages; and there are ſo many ſmall ones, that they are not above a muſket-ſhot from each other.—The houſes are ſmall, round at the top, and encompaſſed with mud walls or hedges, together with a great number of all ſorts of beautiful and lofty trees, which afford the moſt beautiful proſpect in the world, inſomuch that thoſe that have been here repreſent it as a perfect paradiſe. The fields are always green, and they cultivate beans, potatoes, and fruits; nor will the negroes here let a foot of ground remain uncultivated. They ſow again the very next day after they have reaped. The inhabitants are greatly civilized, very reſpectful to each other, eſpecially to their ſuperiors, and very induſtrious. The women brew the beer, dreſs the victuals, and ſell all ſorts of commodities at the market. Thoſe that are rich employ their wives and ſlaves in tilling the land, and they carry on a conſiderable trade with the product, as well as in ſlaves; for ſome of them are able to deliver 1000 of the latter every month. The chief men have generally 40 or 50 wives, the principal captains 300 or 400, and the king 4000 or 5000. They are extremely jealous, and, on the leaſt ſuſpicion, will ſell them to the Europeans for ſlaves. If any one happen to touch one of the king's wives accidentally, he is doomed to perpetual ſlavery. It is no wonder then that the women are not fond of being the king's wives; and ſome of them will prefer a ſpeedy death to ſuch a miſerable life. They have no diſtinction of hours, days, weeks, months, or years. The rite of circumciſion is uſed here; but they are not able to tell why they uſe it, nor whence it is derived. They are ſuch great gameſters, that they will ſtake all they have at play, not excepting their wives and children. They have a vaſt number of idols; and they deify the moſt contemptible animal that they ſee firſt in a morning, and even ſtocks and ſtones. Their principal regard is for ſnakes, very high trees, and the ſea. An Engliſh factor, juſt arrived, found a ſnake in the houſe belonging to the factory, and killed it without the leaſt ſcruple; which ſo incenſed the negroes, that they were for revenging the death of the ſnake, not only upon him that killed it, but upon the whole factory; but by means of preſents, and the interpoſition of the people of the other factories, the affair was made up, and the ſnake honourably interred. However, to prevent ſuch accidents, they gave them warning not to do the like for the future. They have oxen, cows, goats, ſheep, hogs, turkeys, ducks, and hens; which laſt are extremely plentiful. There are many elephants, buffaloes, tigers, ſeveral kinds of deer, and a ſort of hares. The fruits are citrons, lemons, oranges, bananas, tamarinds, &c. and they have vaſt numbers of palm-trees, from which they obtain wine. Whidah was conquered by the king of Dahomy. Their trade conſiſts of ſlaves, elephants teeth, wax, and honey. The Engliſh factory is 200 miles eaſt of Cape Coaſt Caſtle, within land. Bows, arrows, beautiful aſſaguays, and clubs, are the principal weapons of the nation.

WHIDAW-BIRD. See EMBERIZA, ORNITHOLOGY *Index*.

WHIG, a perſon belonging to a political party in Britain, oppoſite to the Tories. See TORIES, and BRITAIN.

WHIMBREL. See SCOLOPAX, ORNITHOLOGY *Index*.

WHIN. See ULEX, BOTANY *Index*.

WHINCHAT. See MOTACILLA, ORNITHOLOGY *Index*.

WHIP, or *WHIP-Staff*, in a ſhip, a piece of timber, in form of a ſtrong ſtaff, faſtened into the helm, for the ſteerſman, in ſmall ſhips, to hold in his hand, in order to move the rudder, and direct the ſhip.

WHIRLPOOL, an eddy, vortex, or gulf, where the water is continually turning round.

Thoſe in rivers are very common, from various accidents, and are uſually very trivial, and of little conſequence. In the ſea they are more rare, but more dangerous. Sibbald has related the effects of a very remarkable marine whirpool among the Orcades, which would prove very dangerous to ſtrangers, though it is of no conſequence to the people who are uſed to it. This is not fixed to any particular place, but appears in various parts of the limits of the ſea among theſe iſlands. Wherever it appears, it is very furious; and boats, &c. would inevitably be drawn in and periſh with it; but the people who navigate them are prepared for it, and always carry an empty veſſel, a log of wood, or large bundle of ſtraw, or ſome ſuch thing, in the boat with them; as ſoon as they perceive the whirlpool, they toſs this within its vortex, keeping themſelves out: this ſubſtance, whatever it be, is immediately received into the centre, and carried under water; and as ſoon as this is done, the ſurface of the place where the whirpool was becomes ſmooth, and they row over it with ſafety; and in about an hour they ſee the vortex begin again in ſome other place, uſually at about a mile's diſtance from the firſt.

WHIRLWIND, a wind which moves in a ſpiral direction, as well as horizontally, which is exceedingly rapid and impetuous, but only of ſhort duration.

Dr Franklin's opinion of the origin of whirlwinds has been already given in the article *Water-Spout*. If his theory be true, it will follow, that no hurricane ever can be ſo violent as to remove an obſtacle of the ſize of only one cubic inch, provided that was ſupported by a power equivalent to 15 pounds; for this is the utmoſt force of the atmoſphere when ruſhing into a perfect vacuum, which never could take place in the centre of a whirlwind or water-ſpout. Indeed, notwithſtanding the dreadful effects ſometimes obſerved from hurricanes and whirlwinds, we ſhall eaſily perceive, that the utmoſt of their power always falls very far ſhort of this. The diminution of the ſpecific gravity of the air by only one-fourth in the middle of the column, would produce ſuch an afflux of air from all quarters, that an obſtacle preſenting a ſurface of one foot ſquare, would require a force of 504 pounds to prevent it from being carried away; which the ſtrongeſt walls that can be built by human art could ſcarce reſiſt. Nay, even the tenth part of this, or the diminution of the gravity of the atmoſphere by one-fortieth part, would produce a preſſure of upwards of 50 pounds on every ſquare foot of ſurface, which, it is to be doubted, whether any of our common houſes could reſiſt.

Some philoſophers aſcribe the vacuum in the atmoſphere, to which, according to Dr Franklin's theory, whirlwinds are owing, to a ſtream of electric matter ruſhing with violence into the atmoſphere out of the earth. But they do not inform us how this matter comes to be accumulated in that part of the earth; what induces it to paſs out of the earth; how it paſſes inviſibly through pure air; or what ſerves it for a conductor. It ſeems to be the faſhion among certain philoſophers to aſcribe every phenomenon, with the cauſe of which we are unacquainted, to electricity. But this is merely ſubſtituting a new name, and ſerves rather to retard than advance our knowledge of nature.

Some kinds of whirlwinds move with a ſlow motion, and are injurious only by their vortex; while others ſeem to do miſchief as well by their progreſſive as their whirling motion. Of this kind are thoſe called *typhons*; which, by their frequently following the courſe of rivers, ſeem thus alſo to diſcover their electrical origin. Of the deſtructive effects of theſe, we have an inſtance in what happened in Charleſtown in South Carolina, on the 1ſt of June 1761. It was firſt obſerved about noon, on land, upwards of 50 miles weſt by ſouth of Charleſtown, and deſtroyed ſeveral houſes, &c. as it paſſed along, in many places making wide avenues through the woods; from whence every tree and ſhrub was torn up, and great branches of trees were driven about in the column as it paſſed along. It directed its courſe to Aſhley river, down which it came with ſurpriſing velocity; in its appearance reſembling a column of ſmoke or vapour, whoſe motion was very irregular and tumultuous. Its momentum was ſo great, that Aſhley river was ploughed to the bottom, and the channel laid bare. As it came down this river, it made a conſtant noiſe like thunder; its diameter being computed about 300 fathoms. It was met at White Point by another of the ſame kind which came down Cooper's river, but with inferior ſtrength; however, on their meeting together, the agitation of the air was much greater, while the clouds, which were driving in all directions to the place, ſeemed to be precipitated, and whirled round with incredible velocity. It then fell upon the ſhipping in the road; entirely deſtroying ſome, and damaging others; being ſcarce three minutes in its paſſage, though the diſtance was near two leagues. In that ſhort time it did damage to the amount of 20,000l.; and had not its direction been altered by that guſt which came down Cooper's river, it muſt have totally deſtroyed Charleſtown, as no obſtacle whatever ſeemed capable of reſiſting its fury.

WHISKY, a term ſignifying *water*, and applied in Scotland and in Ireland to a diſtilled liquor drawn from barley.

WHISPERING-PLACES. See Acoustics, N° 24.

WHIST, a well known game at cards, which requires great attention and ſilence; hence the name.

This game is played by four perſons, who cut for partners; the two higheſt and the two loweſt are together, and the partners ſit oppoſite to each other: the perſon who cuts the loweſt card is to deal firſt, giving one at a time to each perſon, till he comes to the laſt card, which is turned up for the trump, and remains on the table till each perſon has played a card. The perſon on the left hand ſide of the dealer plays firſt, and whoever wins the trick is to play again, thus going on till the cards are played out. The ace, king, queen, and knave of trumps, are called *honours*; in caſe any three of theſe honours have been played between, or by either of the two partners, they reckon for two points towards the game; and if the four honours have been played between, or by either of the two partners, they reckon for four points towards the game, the game conſiſting of ten points. The honours are reckoned after the tricks; all above ſix tricks reckoning alſo towards the game.

General Rules for playing the Game of Whist.—1. He who is to play firſt ſhould lead from the ſtrongeſt ſuit. If he has a ſequence of king, queen, and knave, or queen, knave and ten, he may ſafely lead the higheſt of the ſequence; but if he has five or ſix in number, he muſt begin with the loweſt. He muſt always begin with the higheſt trump, by which he forces out the ſuperior trumps, and can come in again, to make his ſtrong ſuit.

2. He ſhould never be afraid to play trumps when he has five in his hand, even of the ſmalleſt, although he may not have any good cards of any other ſuit.

3. With ace and king of any two ſuits, and only two or three ſmall trumps, the aces and kings ſhould be played out, in order to make as many tricks as poſſible; and having but two or three ſmall trumps, he ſhould never force his partner to trump, if he finds he cannot follow ſuit; but endeavour to throw the lead into his partner's hand.

4. He ſhould in general return his partner's lead, unleſs he has ſome capital cards of his own.

5. As this game is played with the lurch, that is, to ſave half the ſtake, five points muſt be made before the game is out: he ſhould not venture to play trumps when he is four of the game, unleſs he is very ſtrong, having at leaſt an honour and three trumps, or ace, king, and two ſmall ones.

6. When the game is ſcored nine, at which ſtage the honours reckon for nothing, he ſhould be ſtill more cautious how he plays trumps, even if he is ſtrong in hand, and give his partner an opportunity of trumping the adverſaries ſuits, in caſe he is deficient in them.

7. If his adverſaries are ſix or ſeven love of the game, he ſhould play a forward or bold game, that he may have a chance, at the riſk of a trick or two, to come up with them. If he has but three trumps and other good cards, he may play trumps, eſpecially if he has a ſequence, or queen, knave, and a ſmall one.

8. He ſhould always riſk a trick or two when the game is much in his favour; becauſe a new deal is of greater conſequence to the adverſary than one or two points are to him.

9. When the player finds there is a likelihood of either ſaving the game or his lurch, he ſhould riſk the odd trick; but if the game is five all, and he can make two tricks in his own hand, he ſhould make them, in order to ſecure the difference of two points, which make the game near two to one in his favour.

10. A good player ſhould begin with a ſmall trump, when he has ace, king, and four ſmall ones; for this reaſon, if his partner has a better trump than the laſt player, which is an equal wager but he has, he has a chance of fetching out all the trumps, by having three rounds of them.

11. The odds are always in his favour that his partner holds an honour; conſequently if he has king, queen, and four ſmall ones, he ſhould begin with a ſmall one.

12. When queen, knave, and four ſmall trumps are dealt him, he ſhould play a ſmall one firſt, the odds being in his favour that his partner holds an honour; if he has knave, ten, and four ſmall trumps, he ſhould alſo begin with a ſmall one, for the ſame reaſon.

13. If he has knave, ten, eight, and three ſmall trumps, the knave ſhould be played firſt, by which means the nine may be prevented from winning a trick, the odds being in his favour that three honours are played in two rounds.

14. If an honour is turned up againſt him on his left hand, and he has ten, nine, and eight, with two or three ſmall trumps; when he is to play, he ſhould play through the honours with the ten, which will force the dealer to play his honour to a diſadvantage, if the dealer does not chooſe to leave it to the option of his adverſary whether he will paſs it or not; but if he has ſix trumps of a lower denomination, and not ten, nine, and eight, and no honour turned up againſt him, he ſhould begin with a ſmall one.

15. In general, when he has two capital cards in trumps, and two or three ſmall ones, he ſhould begin with a ſmall one, for the reaſon aſſigned in N° 12.

16. When he has ace, king, knave, and two ſmall trumps, or even one ſmall trump, by firſt playing the king, and putting the lead into his partner's hand, who will play a trump; judging him to have ace and knave, from his beginning with the king: in this caſe the knave ſhould be fineſſed (A), nothing being againſt him but the queen.

17. If he has knave, ten, eight, and two ſmall trumps, by playing the knave firſt, it is odds but in two rounds of trumps the nine falls, or he may fineſſe the eight when his partner returns trumps.

18. With five trumps of a lower denomination, he ſhould begin with the ſmalleſt, unleſs he has a ſequence of ten, nine, and eight; then he ſhould begin with the ten.

19. When he has king, queen, ten, and one ſmall trump, he muſt begin with the king, and wait for his partner's return of the trumps, in order to fineſſe the ten, by which means he may win the knave.

20. In order to prevent the ten from winning, when he has queen, knave, nine, and one ſmall trump, he muſt begin with the queen. And in caſe he has knave, ten, eight, and one ſmall trump, he ſhould begin with the knave, that the nine may not win.

21. If he has ten, nine, eight, and one ſmall trump, he ſhould begin with the ten; thereby he ſtrengthens his partner's hand, leaving it at his option to take it or not.

22. He ſhould begin with a ſmall one, when he has the ten and three ſmall trumps.

23. If he has a good ſuit, and ace, king, and four ſmall trumps, he muſt play three rounds of trumps, in order to ſecure his ſtrong ſuit from being trumped.

24. When he has king, queen, ten, and three ſmall trumps, he ſhould begin with the king, becauſe he has a chance of the knave's coming down in the ſecond round; and to ſecure his ſtrong ſuit, he ſhould not wait to fineſſe the ten. If he ſhould have queen, knave, and three ſmall trumps, and ſome good ſuit to make, he muſt begin with a ſmall one.

25. If he has knave, ten, eight, and two ſmall trumps, with a ſtrong ſuit, he ſhould begin with the knave, in order to make the nine fall in the ſecond round; but if he has knave, ten, and three ſmall trumps, with a good ſuit, he ſhould play a ſmall one firſt.

26. With ten, nine, eight, and one ſmall trump, provided he has a good ſuit, he ſhould begin with the ten; by which means he may get the trumps out, and have a chance of making his ſtrong ſuit.

The following obſervations will enable a player to know that his partner has no more of a ſuit which either of

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(A) *Fineſſe*, is to play a ſmall card which may win, keeping the ſuperior card or cards to lay over the right-hand adverſary.

of them has played. Suppoſe he leads from queen, ten, nine, and two ſmall cards of any ſuit, the ſecond hand puts on the knave, his partner plays the eight; in this caſe, he having queen, ten, and nine, it is a demonſtration, if his partner plays well, that he can have no more of that ſuit. By that diſcovery, he may play his game accordingly, either by forcing his partner to trump that ſuit, if he is ſtrong in trumps, or by playing another ſuit. If he has king, queen, and ten of a ſuit, and he leads his king, his partner plays the knave; this alſo demonſtrates he has no more of that ſuit. If he has king, queen, and many more of a ſuit, and begins with the king, in ſome caſes it is good play in a partner, when he has the ace and one ſmall card in that ſuit only, to win the king with the ace; for ſuppoſe the partner to be very ſtrong in trumps, by taking the king with the ace, he gets the lead and trumps out, and having cleared the board of trumps, his partner returns his lead; and the ace being out, there is room for him to make that whole ſuit, which could not have been done if the partner had kept the ace. Suppoſe he has no other good card in his hand beſides that ſuit, he loſes nothing by the ace's taking his king; and if it ſhould ſo happen that he has a good card to bring in that ſuit, he gains all the tricks which he makes to that ſuit by this method of play: as his partner has taken his king with the ace, and trumps out upon it, he has reaſon to imagine that his partner has one of that ſuit to return him; for which reaſon he ſhould not throw away any of that ſuit, even to keep a king or queen guarded.

Method of playing when an honour is turned up on the right hand.—Suppoſe the knave is turned up on his right hand, and that he has king, queen, and ten; in order to win the knave, he muſt begin with the king; by which means, his partner may ſuppoſe him to have queen and ten remaining, eſpecially if he has a ſecond lead, and he does not proceed to play the queen.

Suppoſe the knave turned up as before, and he has ace, queen, and ten, by playing his queen, it anſwers the purpoſe of the former rule.

When the queen is turned up on his right hand, and he has ace, king, and knave, by playing his king, it anſwers the ſame purpoſe of the former rule.

In caſe an honour is turned up on his left hand, ſuppoſing he ſhould hold no honour, he ſhould play trumps through the honour as ſoon as he gets the lead; but if he ſhould hold an honour (except the ace), he muſt be cautious how he plays trumps, becauſe, in caſe his partner holds no honour, his adverſary will play his own game upon him.

Method of playing the ſequences.—The higheſt in ſequences of trumps ſhould be played, unleſs he has ace, king, and queen; and then he ſhould play the loweſt, which informs his partner of the ſtate of his game.

When he has king, queen, and knave, and two ſmall ones, which are not trumps, he ſhould begin with the knave, whether he is ſtrong in trumps or not, as he makes way for the whole ſuit by getting the ace out.

If he is ſtrong in trumps, and has a ſequence of queen, knave, ten, and two ſmall cards of a ſuit, he ſhould play the higheſt of his ſequence; for if either of the adverſaries ſhould trump that ſuit in the ſecond round, being alſo ſtrong in trumps, he will make the remainder of that ſuit, by fetching out the trumps. When he has knave, ten, and nine, and two ſmall cards of a ſuit, he may play in the like manner.

If king, queen, and knave, and one ſmall card of any ſuit, is the caſe, whether ſtrong in trumps or not, he ſhould play the king; and when there are only four in number, the ſame method of play ſhould be obſerved by inferior ſequences.

When weak in trumps, he ſhould begin by the loweſt of the ſequence, provided he has five in number, becauſe if his partner has the ace of that ſuit he will make it. If he has the ace and four ſmall cards of a ſuit, and weak in trumps, leading from that ſuit, he ſhould play the ace. When ſtrong in trumps, the game may be played otherwiſe.

How to make a flam, or win every trick.—Suppoſe A and B partners againſt C and D, and C to deal, A to have the king, knave, and nine, and ſeven of hearts, which are trumps, a quart-major in ſpades, a tierce-major in diamonds, and the ace and king of clubs. Then ſuppoſe B to have nine ſpades, two clubs, and two diamonds. Alſo ſuppoſe D to have ace, queen, ten, and eight of trumps, with nine clubs, and C to have five trumps and eight diamonds. A leads a trump, which D wins, and D is to play a club, which his partner C is to trump; C leads a trump, which his partner D wins; D then will lead a club, which C will trump; and C will play a trump, which D will win; and D having the beſt trump will play it; after which D having ſeven clubs in his hand, makes them, ſo that he flams A and B.

How to play any hand of cards according to the neareſt calculations of his partner's holding certain winning cards:

1. That he has not one certain winning card, is - - 2 to 1
2. That he has not two certain winning cards, is - - 17 to 2
But it is about 5 to 4 that he has one or both, or - - 32 to 25
3. That he has one card out of any three certain winning cards, is about 5 to 2
4. That he has not three certain winning cards is about 31 to 1, or - 681 to 22
5. That he has not two of them, is about 7 to 2, or - - 547 to 156
6. That he has not one of them, is about 7 to 6, or - - 378 to 325
7. That he holds one or two of them, is in his favour about 13 to 6, or 481 to 222
8. And about 5 to 2 that he holds 1, 2, or all three of them.

The uſe of theſe calculations is for a whiſt-player to play his cards to the moſt advantage. For inſtance,

As the firſt calculation is two to one that his partner does not hold one certain winning card.—Suppoſe then a ſuit is led, of which the ſecond player has the king and a ſmall one only, he ſhould put on the king, becauſe the odds are in his favour, that the third player cannot win it. For the ſame reaſon, when he is ſecond player, and to lead, he ſhould play a king in preference to a queen, becauſe it is two to one the ace does not take it; but it is five to four the queen will be taken by either ace or king, which may be in the third hand.

According

According to the ſecond calculation, of its being five to four that his partner holds one certain winning card out of any two: If he has two honours in any ſuit, he can play to an advantage, knowing it is five to four in favour of his partner's having one of the two honours; and by the ſame rule, if he is ſecond player, having a queen and one ſmall card, by playing the queen he plays five to four againſt himſelf.

It is obvious, from the third calculation, which proves it to be five to two that his partner has one card out of any three certain winning cards, that he who plays the knave ſecond hand, having but the knave and one ſmall card of the ſame ſuit, muſt play five to two againſt himſelf, and diſcovers his game to a great diſadvantage; for which reaſon, he ſhould play the loweſt of any ſequence which he may hold in his hand, as the knave, if he has king, queen, and knave; the ten, if he has queen, knave, and ten, &c. By ſo doing, his partner has an opportunity of judging what card to play in that ſuit, according to the odds for or againſt him.

See Hoyle's Games improved by Beaufort.

From the above calculation, if he has ace, king, and two ſmall trumps, he is entitled to win four tricks out of ſix, provided he has four winning cards of any ſuit; or five tricks out of ſeven, if he has five winning cards of any ſuit: by playing two rounds of trumps, and taking out eight of them, it is five to two but his partner has a third trump; and if it ſhould be ſo, he makes the tricks intended.

WHISTON, William, an Engliſh divine of great parts, uncommon learning, and of ſingular character, was born in 1667 at Norton near Twycroſſe in the county of Leiceſter, where his father was rector. He was admitted of Clarehall, Cambridge, where he purſued his ſtudies, particularly in the mathematics, and commenced tutor; which his ill health at length forced him to decline. Having entered into orders, he became chaplain to Dr More biſhop of Norwich in 1694; and in this ſtation he publiſhed his firſt work, entitled A New Theory of the Earth, &c. in which he undertook to prove the Moſaic doctrine of the earth perfectly agreeable to reaſon and philoſophy. This work brought no ſmall reputation to the author. In the beginning of the 18th century he was made Sir Iſaac Newton's deputy, and afterwards his ſucceſſor, in the Lucaſian profeſſorſhip of mathematics; when he reſigned a living he had in Suffolk, and went to reſide at Cambridge. About this time he publiſhed ſeveral ſcientifical works, explanatory of the Newtonian philoſophy; and he had the honour to be one of the firſt, if not the very firſt, who rendered theſe principles popular and intelligible to the generality of readers. About the year 1710, he was known to have adopted Arian principles, and was forming projects to ſupport and propagate them: among other things, he had tranſlated the Apoſtolical Conſtitutions into Engliſh, which favoured the Arian doctrine, and which he aſſerted to be genuine. The conſequence was, that he was deprived of his profeſſorſhip, and baniſhed the univerſity; he nevertheleſs purſued his ſcheme, by publiſhing the next year his Primitive Chriſtianity Revived, 4 vols, 8vo, for which the convocation fell upon him very vehemently. On his expulſion from Cambridge, Mr Whiſton ſettled in London; where, without ſuffering his zeal to be intimidated, he continued to write, and propagate his Primitive Chriſtianity, with as much ardour as if he had been in the moſt flouriſhing circumſtances. In 1721, a ſubſcription was made for the ſupport of his family, which amounted to 470l. For though he drew profits from reading aſtronomical and philoſophical lectures, and alſo from his publications, which were very numerous, yet theſe of themſelves would have been very inſufficient: nor, when joined with the benevolence and charity of thoſe who loved and eſteemed him for his learning, integrity, and piety, did they prevent his being frequently in great diſtreſs. He continued long a member of the church of England, and regularly frequented its ſervice, though he diſapproved of many things in it: but at laſt he went over to the Baptiſts, and attended Dr Forſter's meeting at Pinner's hall, Broadſtreet. Among other performances not ſpecified above, he wrote Memoirs of his own life and writings, which contain ſome curious particulars.

He was remarkable for ſpeaking the plaineſt truths on every occaſion, and to perſons of every degree. During the year 1725, that he, with Dr Clarke, Dr Berkeley, and others, had the honour to attend Queen Caroline on a certain day of every week, to talk of the progreſs of ſcience, her majeſty one evening took occaſion to pay him a juſt compliment on his truth and integrity, requeſting that he would, with his uſual plainneſs, point out to her any fault that he might have obſerved in her conduct. At firſt he begged to be excuſed, adding, that few perſons could bear to have their faults plainly told to them, and leaſt of all royal perſonages, who, from their elevation, are neceſſarily ſurrounded by flatterers, to whoſe lips truth is a ſtranger. Her majeſty, replied, that he was to conſider her not as a queen, but as a philoſopher; and that philoſophy is of very little uſe, if it cannot enable its profeſſors to bear without offence truths neceſſary to their own improvement. Upon this he told her, that the greateſt fault which he had obſerved in her conduct, was her indecent behaviour in the houſe of God, which, he aſſured her, had made very unfavourable impreſſions on the minds of many perſons, who coming to town from diſtant parts of the country, had gone to the chapel to obtain a ſight of her majeſty, the king, and the royal family. The queen made no reply; but in about ſix weeks afterwards renewed her requeſt, that Mr Whiſton would point out the moſt glaring improprieties in her conduct. To this he anſwered, that he had laid down a maxim, from which he could not deviate, never to point out to any perſon more than one fault at a time, and never to give a ſecond reproof till he had obſerved ſome good conſequence to have ariſen from the firſt (A). Much to the queen's honour, ſhe was pleaſed with this plain-dealing, and continued to think favourably of Mr Whiſton. This honeſt, but whimſical and credulous man, died in 1762, at the advanced age of 95.

WHITBY, Dr Daniel, a very learned Engliſh divine, was born at 1638, and bred at Oxford; where, in 1664, he was elected perpetual fellow of his college. He afterwards became chaplain to Dr Seth Ward, bi-

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(A) Biſhop Berkeley was preſent at theſe converſations, and from his ſon we received the account we have given of them. They are likewiſe mentioned, but not ſtated ſo accurately, by Biſhop Newton in his own Life.

ſhop of Saliſbury; who collated him in 1668 to the prebend of Yateſbury in that church, and ſoon after to that of Huſborn and Burbach. In 1672 he was admitted chanter of the ſaid church, on the death of Mr John South, and then, or ſoon after, rector of St Edmund's church in Saliſbury. He was made a prebendary of Taunton Regis in 1696, and died in 1726. He was ever ſtrangely ignorant of worldly affairs, even to a degree that is ſcarcely to be conceived. His writings are numerous, and well known; particularly his Commentary on the New Teſtament.

WHITBY, a ſea-port town in the north riding of Yorkſhire, ſeated on the river Eſk, near the place where it falls into the ſea. The houſes are neat, ſtrong, and convenient; the number of inhabitants about 9000. Ship-building is their principal employment. W. Long. 0. 24. N. Lat. 54. 30.

WHITE, one of the colours of natural bodies.

WHITE of the Eye, denotes the firſt tunic or coat of the eye, called *albuginea*. See ANATOMY, N° 142.

WHITE of Egg. See ALBUMEN and EGG.

WHITE Friars, a name common to ſeveral orders of monks, from being clothed in a white habit.

WHITE Sea, is a bay of the Frozen ocean, ſo called in the north part of Muſcovy, lying between Ruſſian Lapland and Samoieda; at the bottom of which ſtands the city of Archangel. This was the chief port the Ruſſians had before their conqueſt of Livonia.

WHITE Colour, white lead for painting. See CHEMISTRY, N° 1856.

WHITE Iron, or *Tin-plate*, iron-plates covered over with tin; for the method of making which, ſee LATTEN, CHEMISTRY, N° 1956.

In 1681 tin-plates were manufactured in England by one Andrew Yarranton, who had been ſent to Bohemia to learn the method of making them. But the manufacture was ſoon afterwards diſcontinued. It was revived in 1740, and has now arrived at as great, if not greater, perfection in this country than in any other.

WHITE Lead. See CHEMISTRY, N° 1856.

WHITE-Throat. See MOTACILLA, ORNITHOLOGY *Index*.

WHITEFIELD, GEORGE, the celebrated preacher among the people called *Methodiſts*, was born in the year 1714, at the Bell in the city of Glouceſter, which was then kept by his mother. At about 12 years of age he was put to a grammar-ſchool; but his mother entering into a ſecond marriage, which proved a diſadvantageous one, he, when about 15, put on a blue apron, and ſerved her in the capacity of a drawer or waiter. After continuing about a year in this ſervile employment, ſhe turned over the buſineſs to his brother; who marrying, and George not agreeing with his ſiſter-in-law, he left the inn. Some time after, meeting with an old ſchool-fellow, then a ſervitor in Pembroke college, Oxford, he was induced to attempt getting into the ſame college in a like capacity, and ſucceeded. Here Mr Whitefield, who from his own account appears to have always had a ſtrong tincture of enthuſiaſm in his conſtitution from his very childhood, diſtinguiſhed himſelf by the auſterity of his devotion, and acquired conſiderable eminence in ſome religious aſſemblies in that city. At the age of 21, the fame of his piety recommended him ſo effectually to Dr Benſon, then biſhop of Glouceſter, that he made him a voluntary offer of ordination. Immediately after this regular admiſſion into the miniſtry, Mr Whitefield applied himſelf to the moſt extraordinary, the moſt indefatigable, duties of his character, preaching daily in priſons, fields, and open ſtreets, wherever he thought there would be a likelihood of making proſelytes. Having at length made himſelf univerſally known in England, he embarked for America, where the tenets of Methodiſm began to ſpread very faſt under his friends the Weſleys; and firſt determined upon the inſtitution of the orphan-houſe at Georgia, which he afterwards effected. After a long courſe of peregrination, his fortune increaſed as his fame extended among his followers, and he erected two very extenſive buildings for public worſhip, under the name of *Tabernacles;* one in Tottenham-Court Road, and the other in Moorfields. Here, with the help of ſome aſſiſtants, he continued for ſeveral years, attended by very crowded congregations, and quitting the kingdom only occaſionally. Beſides the two tabernacles already mentioned, Mr Whitefield, by being chaplain to the counteſs dowager of Huntingdon, was connected with two other religious meetings, one at Bath, and the other at Tunbridge, chiefly erected under that lady's patronage. By a lively, fertile, and penetrating genius, by the moſt unwearied zeal, and by a forcible and perſuaſive delivery, he never failed of the deſired effect upon his ever crowded and admiring audiences. In America, however, which always engaged much of his attention, he was deſtined to finiſh his courſe; and he died at Newberry, about 40 miles from Boſton in New England, in 1770.

WHITEHAVEN, a ſea-port town of Cumberland, with a market on Tueſday, and one fair on Auguſt 1ſt for merchandiſe and toys. It is ſeated on a creek of the Iriſh ſea, on the north end of a great hill, waſhed by the tide of flood on the weſt ſide, where there is a large rock or quarry of hard white ſtone, which gives name to the place, and which, with the help of a ſtrong ſtone-wall, ſecures the harbour, into which ſmall barks may enter. It is lately much improved in its buildings, and noted for its trade in pit-coal and ſalt, there being near it a valuable coal-mine, which runs a conſiderable way under the ſea. They have a cuſtom-houſe here; and they carry on a good trade to Ireland, Scotland, Cheſter, Briſtol, and other parts. It is 10 miles ſouth-weſt of Cockermouth, and 305 north-weſt of London. W. Long. 3. 34. N. Lat. 54. 36.

WHITENESS, the quality which denominates or conſtitutes a body white.

WHITES, or FLUOR *Albus*. See MEDICINE, N° 250.

WHITING. See GADUS, ICHTHYOLOGY *Index*.

WHITLOW, or WHITLOE. See SURGERY *Index*.

WHITSUN-FARTHINGS, otherwiſe called *Smoke-farthings* or *Quadrantes Pentecoſtales*, a compoſition for offerings which were anciently made in Whitſun-week by every man in England, who occupied a houſe with a chimney, to the cathedral church of the dioceſe in which he lived.

WHITSUNDAY, a ſolemn feſtival of the Chriſtian church, obſerved on the fiftieth day after Eaſter, in memory of the deſcent of the Holy Ghoſt upon the apoſtles in the viſible appearance of fiery cloven tongues, and of thoſe miraculous powers which were then conferred upon them.

It is called *Whitſunday*, or *White-Sunday*; becauſe this being one of the ſtated times for baptiſm in the ancient church, thoſe who were baptiſed put on white garments, as types of that ſpiritual purity they received in baptiſm. As the deſcent of the Holy Ghoſt upon the apoſtles happened upon the day which the Jews called *Pentecoſt*, this feſtival retained the name of *Pentecoſt* among the Chriſtians.

WHITSUNDAY Iſle, one of the New Hebrides, which lies about four miles to the ſouth, runs in the ſame direction, and is of the ſame length, having more ſloping expoſures than Aurora: it appears to be better inhabited, and to contain more plantations.

WHORTLEBERRY. See VACCINIUM, BOTANY *Index*.

WHYTT, DR ROBERT, an eminent phyſician, born at Edinburgh on the 6th September 1714, was the ſon of Robert Whytt, Eſq. of Bennochy, advocate. This gentleman died ſix months before the birth of our author, who had alſo the misfortune to be deprived of his mother before he had attained the ſeventh year of his age. After receiving the firſt rudiments of ſchool-education, he was ſent to the univerſity of St Andrew's; and after the uſual courſe of inſtruction there, in claſſical, philoſophical, and mathematical learning, he came to Edinburgh, where he entered upon the ſtudy of medicine, under thoſe eminent medical teachers, Monro, Rutherford, Sinclair, Plummer, Alſton, and Innes. After learning what was to be acquired at this univerſity, in the proſecution of his ſtudies he viſited foreign countries; and after attending the moſt eminent teachers at London, Paris, and Leyden, he had the degree of Doctor of Phyſic conferred upon him by the univerſity of Rheims in 1736, being then in the 22d year of his age.

Upon his return to his native country, he had the ſame honour alſo conferred upon him by the univerſity of St Andrew's; where he had before obtained, with applauſe, the degree of Maſter of Arts.

Not long afterwards, in the year 1737, he was admitted a Licentiate of Medicine by the Royal College of Phyſicians of Edinburgh; and the year following he was raiſed to the rank of a Fellow of the College. From the time of his admiſſion as a licentiate, he entered upon the practice of phyſic at Edinburgh; and the reputation which he acquired for medical learning, pointed him out as a fit ſucceſſor for the firſt vacant chair in the univerſity. Accordingly, when Dr Sinclair, whoſe eminent medical abilities, and perſuaſive powers of oratory, had contributed not a little to the rapid advancement of the medical ſchool of Edinburgh, found that thoſe conſpicuous talents which he poſſeſſed could no longer be exerted in the manner which they once had been, when he enjoyed bodily vigour unimpaired by age and powers of mind unclouded by diſeaſe, he reſigned his academical appointments in favour of Dr Whytt.

This admiſſion into the college took place on the 20th of June 1746; and he began his firſt courſe of the inſtitutions of medicine at the commencement of the next winter-ſeſſion. The abilities which he diſplayed from his academical chair, in no particular diſappointed the expectations which had been formed of his lectures. The Latin tongue was the language of the univerſity of Edinburgh; and he both ſpoke and wrote in Latin with ſingular propriety, elegance, and perſpicuity. At that time the ſyſtem and ſentiments of Dr Boerhaave, which, notwithſtanding their errors, muſt challenge the admiration of lateſt ages, were very generally received by the moſt intelligent phyſicians in Britain. Dr Whytt had no ſuch idle ardour for novelties as to throw them entirely aſide becauſe he could not follow them in every particular. The inſtitutions of Dr Boerhaave, therefore, furniſhed him with a text for his lectures; and he was no leſs ſucceſsful in explaining, illuſtrating, and eſtabliſhing the ſentiments of the author, when he could freely adopt them, than in refuting them by clear, connected, and deciſive arguments, when he had occaſion to differ from him. The opinions which he himſelf propoſed, were delivered and enforced with ſuch acuteneſs of invention, ſuch diſplay of facts and force of argument, as could rarely fail to gain univerſal aſſent from his numerous auditors; but free from that ſelf-ſufficiency which is ever the offspring of ignorance and conceit, he delivered his concluſions with becoming modeſty and diffidence.

From the time that he firſt entered upon an academical appointment, till the year 1756, his prelections were confined to the inſtitutions of medicine alone. But at that period his learned colleague Dr Rutherford, who then filled the practical chair, who had already taught medicine at Edinburgh with univerſal applauſe for more than thirty years, and who had been the firſt to begin the inſtitution of clinical lectures at the Royal Infirmary, found it neceſſary to retire from the fatiguing duties of an office to which the progreſs of age rendered him unequal. On this criſis Dr Whytt, Dr Monro, ſen. and Dr Cullen, each agreed to take a ſhare in an appointment in which their united exertions promiſed the higheſt advantages to the univerſity. By this arrangement ſtudents, who had an opportunity of daily witneſſing the practice of three ſuch teachers, and of hearing the grounds of that practice explained, could not fail to derive the moſt ſolid advantages.

In theſe two departments, the inſtitutions of medicine in the univerſity, and the clinical lectures in the Royal Infirmary, Dr Whytt's academical labours were attended with the moſt beneficial conſequences both to the ſtudents and to the univerſity. But not long after the period we have laſt mentioned, his lectures on the former of theſe ſubjects underwent a conſiderable change. About this time the illuſtrious Gaubius, who had ſucceeded to the chair of Boerhaave, favoured the world with his *Inſtitutiones Pathologiæ*. This branch of medicine had indeed a place in the text which Dr Whytt formerly followed; but, without detracting from the character of Dr Boerhaave, it may juſtly be ſaid, that the attention he had beſtowed upon it was not equal to its importance. Dr Whytt was ſenſible of the improved ſtate in which pathology now appeared in the writings of Boerhaave's ſucceſſor; and he made no delay in availing himſelf of the advantages which were then afforded.

In the year 1762, his pathological lectures were entirely new-modelled. Following the publication of Gaubius as a text, he delivered a comment, which was read by every intelligent ſtudent with the moſt unfeigned ſatisfaction. In theſe lectures he collected and condenſed the fruits of accurate obſervation and long experience. Enriched by all the opportunities of information which

which he had enjoyed, and by all the diſcernment which he was capable of exerting, they were juſtly conſidered as his moſt finiſhed production.

For a period of more than twenty years, during which he was juſtly held in the higheſt eſteem as a lecturer at Edinburgh, it may readily be ſuppoſed that the extent of his practice correſponded to his reputation. In fact, he received both the firſt emoluments, and the higheſt honours, which could here be obtained. With extenſive practice in Edinburgh, he had numerous conſultations from other places. His opinion on medical ſubjects was daily requeſted by his moſt eminent contemporaries in every part of Britain. Foreigners of the firſt diſtinction, and celebrated phyſicians in the moſt remote parts of the Britiſh empire, courted an intercourſe with him by letter. Beſides private teſtimonies of eſteem, many public marks of honour were conferred upon him both at home and abroad. In 1752, he was elected a fellow of the Royal Society of London; in 1761, he was appointed firſt phyſician to the king in Scotland; and in 1764, he was choſen preſident of the Royal College of Phyſicians at Edinburgh.

But the fame which Dr Whytt acquired as a practitioner and teacher of medicine, were not a little increaſed by the information which he communicated to the medical world in different publications. His celebrity as an author was ſtill more extenſive than his reputation as a profeſſor.

His firſt publication, An Eſſay on the Vital and other Involuntary Motions of Animals, although it had been begun ſoon after he had finiſhed his academical courſe of medical education, did not come from the preſs till 1751; a period of fifteen years from the time that he had finiſhed his academical courſe, and obtained a degree in medicine: but the delay of this publication was fully compenſated by the matter which it contained, and the improved form under which it appeared.

The next ſubject which employed the pen of Dr Whytt was one of a nature more immediately practical. His Eſſay on the Virtues of Lime-water and Soap in the Cure of the Stone, firſt made its appearance in a ſeparate volume in 1752. Part of this ſecond work had appeared ſeveral years before in the Edinburgh Medical Eſſays: but it was now preſented to the world as a diſtinct publication with many improvements and additions.

His third work, intitled Phyſiological Eſſays, was firſt publiſhed in the year 1755. This treatiſe conſiſted of two parts; 1ſt, An Inquiry into the Cauſes which promote the Circulation of the Fluids in the very ſmall Veſſels of Animals; and 2dly, Obſervations on the Senſibility and Irritability of the Parts of Men and other Animals, occaſioned by Dr Haller's treatiſe on that ſubject. The former of theſe may be conſidered as an extenſion and farther illuſtration of the ſentiments which he had already delivered in his Eſſay on the Vital Motions, while the latter was on a ſubject of a controverſial nature. In both he diſplayed that acuteneſs of genius and ſtrength of judgement which appeared in his former writings.

From the time at which his Phyſiological Eſſays were publiſhed, ſeveral years were probably employed by our author in preparing for the preſs a larger and perhaps a more important work than any yet mentioned, his Obſervations on the Nature, Cauſes, and Cure of thoſe Diſorders which are commonly called *nervous*, *hypochondriac*, and *hyſteric*. This elaborate and uſeful work was publiſhed in the year 1764.

The laſt of Dr Whytt's writings is intitled, Obſervations on the Dropſy in the Brain. This treatiſe did not appear till two years after his death; when all his other works were collected and publiſhed in one quarto volume, under the direction of his ſon and of his intimate friend the late Sir John Pringle.

Beſides theſe five works, he wrote many other papers, which appeared in different periodical publications; particularly in the Philoſophical Tranſactions, the Medical Eſſays, the Medical Obſervations, and the Phyſical and Literary Eſſays.

At an early period of life, ſoon after he had ſettled as a medical practitioner in Edinburgh, he entered into the married ſtate. His firſt wife was Miſs Robertſon, ſiſter to General Robertſon governor of New York. By her he had two children; both of whom died in early infancy, and their mother did not long ſurvive them. A few years after the death of his firſt wife, he married as a ſecond wife Miſs Balfour, ſiſter to James Balfour, Eſq. of Pilrig. By her he had fourteen children; but in theſe alſo he was in ſome reſpects unfortunate; for ſix of them only ſurvived him, three ſons and three daughters, and of the former two are ſince dead. Although the feeling heart of Dr Whytt, amidſt the diſtreſſes of his family, muſt have often ſuffered that uneaſineſs and anxiety which in ſuch circumſtances is the unavoidable conſequence of parental affection and conjugal love; yet he enjoyed a large ſhare of matrimonial felicity. But his courſe of happineſs was terminated by the death of his wife, which happened in the year 1764: and it is not improbable that this event had ſome ſhare in haſtening his own death; for in the beginning of the year 1765 his health was ſo far impaired, that he became incapable of his former exertions. A tedious complication of chronical ailments, which chiefly appeared under the form of diabetes, was not to be reſiſted by all the medical ſkill which Edinburgh could afford; and at length terminated in death, on the 15th of April 1766, in the 52d year of his age.

WIBURGH, a conſiderable town of Denmark, in North Jutland, with a biſhop's ſee, remarkable for being the ſeat of the chief court of juſtice in the province. The hall where the council aſſembles has the archives of the country, and eſcaped the terrible fire that happened in the year 1726, and which burned the cathedral-church, that of the Black Friars, the town-houſe, and the biſhop's palace; but they have all been rebuilt more magnificent than before. It is ſeated on the lake Weter, in a peninſula, 25 miles north-weſt of Sleſwick, and 110 north-by-weſt of Copenhagen. E. Long. 9. 50. N. Lat. 56. 20.

WICK, a royal borough on the eaſt coaſt of the county of Caithneſs. It is ſmall, and the ſtreets narrow, but a few of its buildings are an ornament to the place. The preſent harbour is very inconvenient, but it is propoſed to erect a new one, which will be of great importance to the ſafety of navigation along that coaſt. The population of the whole pariſh in 1793 amounted to 5000.

WICKER, ſignifies made of ſmall twigs.

WICKET, a ſmall door in the gate of a fortified place,

place, &c. or a hole in a door through which to view what paſſes without.

WICKLIFF, John, the firſt divine in Europe who had reſolution to attempt a reformation of religion, was born about the year 1324, in the pariſh of Wycliff, near Richmond, in Yorkſhire. He was educated at Oxford, firſt in Queen's and afterwards in Merton college, of which he was a probationer-fellow. Having acquired the reputation of a man of great learning and abilities, in 1361 he was choſen maſter of Baliol-hall, and in 1365 conſtituted warden of Canterbury college, by the founder Archbiſhop Simon de Iſlip; but in 1367, he was ejected by the regulars, together with three ſecular fellows. He thought their proceedings arbitrary, and therefore appealed to the pope; but inſtead of obtaining redreſs, the ejectment was confirmed in 1370. This diſappointment probably contributed ſomewhat towards his enmity to the ſee of Rome, or rather to confirm that enmity; for he had long before written againſt the pope's exactions and corruptions of religion. However, his credit in the univerſity continued; for having taken the degree of doctor in divinity, he read public lectures with great applauſe; in which he frequently expoſed the impoſitions of the Mendicant friars. About this time he publiſhed a defence of his ſovereign Edward III. againſt the pope, who had inſiſted on the homage to which his predeceſſor King John had agreed. This defence was the cauſe of Wickliff's introduction at court, and of his being ſent one of the ambaſſadors in 1374 to Bruges, where they met the pope's nuncios, in order to ſettle ſeveral eccleſiaſtical matters relative to the pope's authority. In the mean time Wickliff was preſented by the king to the rectory of Lutterworth in Leiceſterſhire, and in 1375 he obtained a prebend in the church of Weſtbury in Glouceſterſhire. Wickliff continued hitherto, without moleſtation, to oppoſe the papal authority; but in 1377 a bull was ſent over to the archbiſhop of Canterbury, and to Courtney biſhop of London, ordering them to ſecure this arch-heretic, and lay him in irons; at the ſame time the pope wrote to the king, requeſting him to favour the biſhops in the proſecution; he alſo ſent a bull to Oxford, commanding the univerſity to give him up. Before theſe bulls reached England Edward III. was dead; and Wickliff, protected by John duke of Lancaſter, uncle to Richard II. favoured by the queen-mother, and ſupported by the citizens of London, eluded the perſecution of Pope Gregory IX. who died in 1378. In the following year this intrepid reformer preſented to parliament a ſevere paper againſt the tyranny of Rome, wrote againſt the papal ſupremacy and infallibility, and publiſhed a book *On the Truth of the Scriptures*, intended to prepare the way for an Engliſh tranſlation of them, in which he had made conſiderable progreſs. In 1381 he publiſhed *Sixteen Concluſions;* in the firſt of which he ventured to expoſe the grand article of tranſubſtantiation. Theſe concluſions being condemned by the chancellor of Oxford, Wickliff appealed to the king and parliament; but being deſerted by his unſteady patron the duke of Lancaſter, he was obliged to make a confeſſion at Oxford; and by an order from the king was expelled the univerſity. He now retired to his living of Lutterworth, where he finiſhed his tranſlation of the bible. This verſion, of which there are ſeveral manuſcript copies in the libraries of the univerſities, Britiſh Muſeum, &c. is a very literal tranſlation from the Latin vulgate. In 1383 he was ſuddenly ſtruck with the palſy; a repetition of which put an end to his life in December 1384. He was buried in his own church, where his bones were ſuffered to reſt in peace till the year 1428, when, by an order from the pope, they were taken up and burnt.—Beſides a number of works that have been printed, he left a prodigious number of manuſcripts; an accurate liſt of which may be ſeen in Biſhop Tanner's *Bib. Brit. Hib.* Some of them are in the Bodleian Library, others in the Britiſh Muſeum, &c.

Wickliff was doubtleſs a very extraordinary man, conſidering the times in which he lived. His natural ſagacity diſcovered the abſurdities and impoſitions of the church of Rome, and he had the honeſty and reſolution to promulgate his opinions, which a little more ſupport would probably have enabled him to eſtabliſh: they were evidently the foundation of the ſubſequent reformation.

WICKLOW, a county of Ireland, in the province of Leinſter; bounded on the north by the county of Dublin; on the eaſt by the Iriſh ſea; on the ſouth by Wexford; and on the weſt by Kildare and Catherlough. It is 33 miles in length, 20 in breadth, and indifferently fruitful. It contains 54 pariſhes, and formerly ſent 10 members to the Iriſh parliament.

Wicklow, the capital of a county of the ſame name, in Ireland; ſeated on the ſea-ſide, with a narrow harbour, at the mouth of the river Leitrim, over which ſtands a rock, inſtead of a caſtle, ſurrounded by a ſtrong wall, 24 miles ſouth of Dublin. W. Long. 6. 7. N. Lat. 52. 55.

WIDGEON. See Anas, Ornithology *Index*.

WIDOW, a woman who has loſt her huſband.

WIFE, a married woman, or one joined with, and under the protection of, an huſband. See Husband.

Isle of WIGHT, an iſland lying on the ſouth coaſt of Hampſhire, from which it is ſeparated by a narrow channel. It is about 21 miles in length and 13 in breadth. It is nearly divided into equal parts by the river Mede or Cowes, which riſing in the ſouthern angle, enters at the northern, into the channel, oppoſite the mouth of Southampton bay. The ſouth-coaſt is edged with very ſteep cliffs of chalk and freeſtone, hollowed into caverns in various parts. The weſt ſide is fenced with ridges of rocks, of which the moſt remarkable are thoſe called, from their ſharp extremities, the *Needles*. Between the iſland and the main are various ſand-banks, eſpecially off the eaſtern part, where is the ſafe road of St Helen's. Acroſs the iſland, from eaſt to weſt, runs a ridge of hills, forming a tract of fine downs, with a chalky or marly ſoil, which feed a great number of fine-fleeced ſheep. Rabbits are alſo very plentiful here. To the north of this ridge the land is chiefly paſture: to the ſouth of it is a rich arable country, producing great crops of corn. The variety of proſpects which this iſland affords, its mild air, and the neat manner in which the fields are laid out, render it a very delightful ſpot. It is devoted almoſt ſolely to huſbandry, and has no manufactory. It is one of the principal reſources of the London market for unmalted barley. Among its products are to be reckoned a pure white pipe-clay, and a fine white cryſtalline ſand; of the latter of which great quantities are exported for the uſe of the glaſs work in various parts. Its principal town is

the

the borough of Newport; it likewiſe contains the two ſmall boroughs of Newton and Yarmouth.

WIGTON, a royal borough, and capital of that diſtrict of Galloway to which it gives name. It is of conſiderable antiquity, and few of its houſes have been lately erected. It is ſuppoſed to have been a place of ſome conſequence in the ninth century, and that it was made a royal borough in the reign of Robert Bruce. It is governed by a provoſt, two bailies, and 12 counſellors; is extremely healthy, and furniſhes many inſtances of longevity. In 1755, the population amounted to 1032, and the whole pariſh in 1793 was 1350.

WIGTONSHIRE, ſometimes denominated *Upper* or *Weſt Galloway*, is about 30 miles long, and 12 broad. It is bounded on the ſouth-eaſt by the bay of Wigton, by which it is ſeparated from Kirkcudbright; on the ſouth and weſt by the ocean; on the north by Ayrſhire; and on the eaſt by Kirkcudbright. The coaſt is tolerably fertile, but improvements in agriculture are ſtill in their infancy. The interior and northern parts are hilly and barren, fit only for ſheep and black cattle. It contains three royal boroughs, viz. Wigton, Stranraer, and Whithorn, with a number of ſeats belonging to noblemen and gentlemen. It is divided into 17 pariſhes; and, according to a cenſus taken ſince the paſſing of the population act in 1801, the population amounted to 22,918, being an increaſe of 6452 ſince the return to Dr Webſter in 1755. The valued rent is 67,646l. Scots, while the real rent is computed at 53,890l. ſterling.

The following is the population according to the pariſhes at two different periods *:

	Pariſhes.	Population in 1755.	Population in 1790—1798.
	Glaſſerton - -	809	900
	Inch - - -	1513	1450
	Kirkcolm - -	765	945
	Kirkinner - -	792	1152
5	Kirkmaiden - -	1051	1380
	Kirkowan - -	795	690
	Leſwalt - -	652	1194
	Luce, New - -	459	400
	Luce, Old - -	1509	1200
10	Mochrum - -	828	1400
	Penninghame -	1509	2000
	Port Patrick - -	611	996
	Sorbie - -	968	1069
	Stranraer - .	610	1602
15	Stoneykirk - -	1151	1365
	Whithorn - -	1412	1890
17	Wigton - -	1032	1350
	Total,	16,466	20,983
			16,466
	Increaſe,		4,517

WILD-FIRE. See *Wild-Fire.*

WILDERNESS, in *Gardening*, a kind of grove of large trees, in a ſpacious garden, in which the walks are commonly made either to interſect each other in angles, or have the appearance of meanders and labyrinths.

Wilderneſſes (ſays Mr Miller) ſhould always be proportioned to the extent of the gardens in which they are made; for it is very ridiculous to ſee a large wilderneſs planted with tall trees in a ſmall ſpot of ground; and, on the other hand, nothing can be more abſurd than to ſee little paltry ſquares, or quarters of wilderneſs-work, in a magnificent large garden. As to the ſituation of wilderneſſes, they ſhould never be placed too near the habitation, nor ſo as to obſtruct any diſtant proſpect of the country, there being nothing ſo agreeable as an unconfined proſpect: but where, from the ſituation of the place, the light is confined within the limits of the garden, nothing can ſo agreeably terminate the proſpect as a beautiful ſcene of the various kinds of trees judiciouſly planted; and if it is ſo contrived that the termination is planted circularly, with the concave towards the ſight, it will have a much better effect than if it end in ſtraight lines or angles. The plants ſhould always be adapted to the ſize of the plantation; for it is very abſurd for tall trees to be planted in the ſmall ſquares of a little garden; and in large deſigns ſmall ſhrubs will have a mean appearance. It ſhould alſo be obſerved never to plant evergreens amongſt deciduous trees; but always to place the evergreens in . wilderneſs in a ſeparate part by themſelves, and that chiefly in ſight.

As to the walks, thoſe that have the appearance of meanders, where the eye cannot diſcover more than twenty or thirty yards in length, are generally preferable to all others, and theſe ſhould now and then lead into an open circular piece of graſs; in the centre of which may be placed either an obeliſk, ſtatue, or fountain; and if in the middle of the wilderneſs there be contrived a large opening, in the centre of which may be erected a dome or banqueting houſe, ſurrounded with a green plot of graſs, it will be a conſiderable addition to the beauty of the whole. From the ſides of the walks and openings, the trees ſhould riſe gradually one above another to the middle of the quarters; where ſhould always be planted the largeſt growing trees, ſo that the heads of all the trees may appear to view, while their ſtems will be hid from the ſight. Thus, in thoſe parts which are planted with deciduous trees, roſes, honeyſuckles, ſpiræa frutex, and other kinds of low flowering ſhrubs, may be planted next the walks and openings; and at their feet, near the ſides of the walks, may be planted primroſes, violets, daffodils, &c. not in a ſtraight line, but ſo as to appear accidental, as in a natural wood. Behind the firſt row of ſhrubs ſhould be planted ſyringas, althæa frutex, mezereons, and other flowering ſhrubs of a middle growth; and theſe may be backed with many other ſorts of trees riſing gradually to the middle of the quarters.

The part planted with evergreens may be diſpoſed in the following manner, viz. in the firſt line next the great walks may be placed the lauruſtinus, boxes, ſpurge laurel, juniper, ſavin, and other dwarf evergreens. Behind theſe may be placed laurels, hollies, arbutuſes, and other evergreens of a larger growth. Next to theſe may be planted alaternuſes, phyllireas, yews, cypreſſes, Virginian cedars, and other trees of the ſame growth; behind theſe may be planted Norway and ſilver firs, the true pine, and other ſorts of the fir growth; and in the middle ſhould be planted Scotch pines, pinaſter, and other ſorts of the larger growing evergreens;

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* Statiſt. Hiſt. vol. xx.

evergreens; which will afford a moſt delightful proſpect if the different ſhades of the greens are curiouſly intermixed.

But beſide the grand walks and openings (which ſhould always be laid with turf, and kept well mowed), there ſhould be ſome ſmaller ſerpentine walks through the middle of the quarters, where perſons may retire for privacy; and by the ſides of theſe private walks may alſo be ſcattered ſome wood-flowers and plants; which, if artfully planted, will have a very good effect.

In the general deſign theſe wilderneſſes, there ſhould not be a ſtudied and ſtiff correſpondency between the ſeveral parts; for the greater diverſity there is in the diſtribution of them, the more pleaſure they will afford.

WILKIE, William, D. D. author of a heroic poem called the *Epigoniad*, was born in the pariſh of Dalmeny in Weſt Lothian in Scotland, in October 1721. His father was a ſmall farmer, and was not very fortunate in his worldly affairs. He gave his ſon, however, a liberal education, the early part of which he received at the pariſh ſchool of Dalmeny, and at the age of 13 he was ſent to the univerſity of Edinburgh, where he was ſoon diſtinguiſhed as a young man of genius. Among his fellow-ſtudents were Dr Robertſon the hiſtorian, Mr Home the poet, and ſome other eminent literary characters. He became acquainted alſo, in the courſe of his education, with David Hume and Dr Adam Ferguſon.

Before he completed his ſtudies at the univerſity, his father died, leaving him only the ſtock and unexpired leaſe of his farm, with the care of three ſiſters, one of whom being afterwards married to an experienced farmer, Wilkie availed himſelf of his practical knowledge. He formed a ſyſtem of farming which fully anſwered his own expectations, and ſecured to him the approbation of all his neighbours. After becoming a preacher in the church of Scotland, he ſtill continued his former mode of living, cultivating his farm, reading the claſſics, and occaſionally preaching for the miniſters in the neighbourhood. In 1753, he was preſented to the church of Ratho by the earl of Lauderdale, who was ſenſible of his worth, and admired his genius. The duties of his new office he diſcharged with fidelity, and was celebrated for his impreſſive mode of preaching, while he did not neglect the amuſements of huſbandry, and the ſtudy of the belles lettres. He publiſhed his Epigoniad in the year 1757, the reſult of fourteen years ſtudy, and a ſecond edition of it was called for in 1759, in which year he was choſen profeſſor of natural philoſophy in the univerſity of St Andrews. His whole fortune, when he removed to this place, did not exceed 200l. which he laid out in the purchaſe of a few acres of land in the vicinity of the city. He lived in the univerſity in the ſame ſtudious and retired manner as he had done at Ratho. In the year 1768 he publiſhed a volume of fables of no great celebrity, prior to which the univerſity conferred on him the degree of D. D. He died, after a lingering illneſs, on the 10th of October 1772.

The manners of Dr Wilkie were in many reſpects very ſingular, and in ſome quite diſguſting. For the purpoſe of promoting perſpiration, and thus removing an aguiſh complaint, with which he had been ſeized during his reſidence at Ratho, he generally ſlept in winter under no fewer than 24 blankets. His averſion to clean linen is altogether unaccountable. It is ſaid that when he ſlept from home, he not only ſtipulated for the proper quantity of blankets, but requeſted to be indulged with ſheets which had been previouſly uſed by ſome other perſon. It is ſcarcely neceſſary to add, that his dreſs was ſlovenly in the extreme. It is ſomewhat remarkable, that Dr Wilkie never could read aloud the ſmootheſt verſe in ſuch a manner as to preſerve either the meaſure or the ſenſe, although his own compoſitions in verſe are greatly diſtinguiſhed by their ſmoothneſs and elegance.

It is ſaid that Dr Wilkie, from having ſtudied Homer with great attention, was led to project an epic poem on the model of that ancient poet. The ſubject of it is drawn from the fourth book of the Iliad, where Sthenelus gives Agamemnon a ſhort account of the ſacking of Thebes; and as that city was taken by the ſons of thoſe who had fallen before it, our author gave to his poem the title of Epigoniad, from the Greek word επιγονοι, ſignifying *deſcendants*. This title, it is ſuppoſed, is not very appropriate, and is not altogether free from quaintneſs. The ſubject of the poem has not been ſelected with much judgement; for the learned reader will prefer ſtudying the manners and actions of ancient heroes in the ſublime deſcriptions of Homer and Virgil, and others will be little intereſted in ſcenes and characters ſo different from thoſe with which they are familiar, and ſo far removed from their own times. Accordingly, the Epigoniad, with all its merit as an epic poem (and it is not deſtitute of many of the eſſential requiſites of that ſpecies of poetical compoſition), is now little known.

WILKINS, Dr John, a moſt ingenious and learned Engliſh biſhop, was the ſon of a goldſmith of Oxford, and was born in 1614. He adhered to the parliament during the civil wars, by whom he was made warden of Wadham college in 1648: he married afterwards the ſiſter of Oliver Cromwell, and procured a diſpenſation to retain his wardenſhip notwithſtanding. Richard Cromwell made him maſter of Trinity college, Cambridge, from which he was ejected on the Reſtoration. He then became preacher to Gray's-Inn, rector of St Laurence Jewry, London, dean of Rippon, and in 1688 was promoted to the biſhopric of Cheſter. He died in 1672. Biſhop Wilkins thought it prudent to ſubmit to the powers in being; he therefore ſubſcribed to the ſolemn league and covenant while it was enforced, and was equally ready to ſwear allegiance to King Charles when he was reſtored: this, with his moderate ſpirit toward diſſenters, rendered him not very agreeable to churchmen. His mathematical and philoſophical works, which contain many ingenious and curious pieces, conſidering the time when they were writtten, have been collected in one vol. 8vo. He publiſhed alſo ſome theological tracts. He was the firſt preſident of the Royal Society.

WILL, that faculty of the mind by which it embraces or rejects any thing offered to it. See Metaphysics.

Will, or *Laſt Will*, in *Law*, ſignifies the declaration of a man's mind and intent relating to the diſpoſition of his lands, goods, or other eſtate, or of what he would have done after his death. In the common law there is a diſtinction made between a will and a teſtament:

ment: that is called a *will* where lands or tenements are given; and when the diſpoſition concerns goods and chattels alone, it is termed a *teſtament*. See TESTAMENT.

WILL-with-a-wiſp, or *Jack-with-a-lanthorn*, two popular names for the meteor called *ignis fatuus*. See LIGHT, N° 46.

WILLIAM *of* MALMSBURY, an hiſtorian of conſiderable merit in the reign of King Stephen; but of whoſe life few particulars are known. According to Bale and Pits, he was ſurnamed *Somerſetus*, from the county in which he was born. From his own preface to his ſecond book *De Regibus Anglorum*, it appears that he was addicted to learning from his youth; that he applied himſelf to the ſtudy of logic, phyſic, ethics, and particularly to hiſtory. He retired to the Benedictine convent at Malmſbury, became a monk, and was made precentor and librarian; a ſituation which much favoured his intention of writing the hiſtory of this kingdom. In this monaſtery he ſpent the remainder of his life, and died in the year 1142. He is one of our moſt ancient and moſt faithful hiſtorians. His capital work is that intitled *De Regibus Anglorum*, in five books; with an Appendix, which he ſtyles *Hiſtoriæ Novellæ*, in two more. It is a judicious collection of whatever he found on record relative to England, from the invaſion of the Saxons to his own times.

WILLIAM of Newbury, ſo called from a monaſtery in Yorkſhire, of which he was a member, wrote a hiſtory which begins at the Conqueſt and ends at the year 1197. His Latin ſtyle is preferred to that of Matthew Paris; and he is intitled to particular praiſe, for his honeſt regard to truth, in treating the fables of Jeffery of Monmouth with the contempt they deſerve; as well as for expreſſing his approbation of Henry II.'s deſign of reforming the clergy, by bringing them under the regulation of the ſecular power.

WILLIAM of Wykeham, biſhop of Wincheſter, was born in the village of Wykeham, in the county of Southampton, in 1324. He was educated at Wincheſter and Oxford; and having continued near ſix years in the univerſity, his patron Nicholas Wedal, governor of the province of Southampton, took him into his family, and appointed him his counſellor and ſecretary. He could not have made choice of a fitter perſon for that employment, no man in that age writing or ſpeaking more politely than Wykeham. For this reaſon Edington, biſhop of Wincheſter, lord high-treaſurer of the kingdom, appointed him his ſecretary three years after, and alſo recommended him to King Edward III. who took him into his ſervice. Being ſkilled in geometry and architecture, he was appointed ſurveyor of the royal buildings, and alſo chief juſtice in eyre: he ſuperintended the building of Windſor-caſtle. He was afterward chief ſecretary of ſtate, a keeper of the privy ſeal; and in 1367 ſucceeded Edington in the ſee of Wincheſter. A little after he was appointed lord high-chancellor and preſident of the privy-council. That he might well diſcharge the ſeveral functions of his employments, both eccleſiaſtical and civil, he endeavoured, on one hand, to regulate his own life according to the ſtricteſt maxims, and to promote ſuch pariſh-prieſts only as were able to give due inſtructions to their pariſhioners, and at the ſame time led exemplary lives: on the other hand, he did all in his power to cauſe juſtice to be impartially adminiſtered. In 1371 he reſigned his chancellorſhip, and ſome time after the great ſeal. Edward returning to England, after having carried on a very ſucceſsful war in France, found his exchequer in great diſorder. The duke of Lancaſter, one of his ſons, at the head of ſeveral lords, having brought complaints againſt the clergy, who then enjoyed the chief places in the kingdom, the king removed them from their employments. But the laymen, who were raiſed to them, behaved ſo ill, that the king was forced to reſtore the eccleſiaſtics. The duke of Lancaſter ſhowed ſtrong animoſity to the clergy, and ſet every engine at work to ruin Wykeham. He impeached him of extortion, and of diſguiſing things, and obliged him to appear at the King's-bench. He got ſuch judges appointed as condemned him; and not ſatisfied with depriving him of all the temporalities of his biſhopric, he adviſed Edward to baniſh him: but this prince rejected the propoſal, and afterward reſtored to Wykeham all that he had been diveſted of. Richard II. was but eleven years old when Edward died: ſo that the duke of Lancaſter had an eaſy opportunity of reviving the accuſations againſt the biſhop of Wincheſter: nevertheleſs Wykeham cleared himſelf. Then he founded two noble colleges, the one in Oxford, the other in Wincheſter. Whilſt he was exerting his utmoſt endeavours to improve theſe two fine foundations, he was recalled to court, and in a manner forced to accept of the office of lord high-chancellor in 1389.—Having excellently diſcharged the duties of that employment for three years, he obtained leave to reſign it, foreſeeing the diſturbances that were going to break out. Being returned to his church, he finiſhed his college, and built there ſo magnificent a cathedral, that it almoſt equals that of St Paul's in London. He laid out ſeveral ſums in things advantageous to the public and to the poor; notwithſtanding which, in 1397 he was in great danger; for he and ſome others were impeached of high-treaſon in open parliament: however, he was again fully cleared. From that time till his death he kept quiet in his dioceſe, and there employed himſelf in all the duties of a good prelate. He died in 1404, in the 81ſt year of his age.

WILLIAM, the name of ſeveral kings of England. See ENGLAND, N° 87—92, and BRITAIN, N° 302.

Fort-WILLIAM, a fortreſs in the Highlands of Scotland, erected in King William's reign, as was alſo a ſmall town adjoining, called *Maryburgh*, in honour of his queen. It is ſituated in Inverneſs-ſhire, on a narrow arm of the ſea called *Loch Eil*, which by the completion of the Caledonian canal, will be united to the Weſtern ſea. Fort-William is of a triangular form, having two baſtions, and is capable of admitting a garriſon of 800 men; but could not be defended againſt an attack, as it is commanded by ſeveral hills in the neighbourhood.

WILLIAM's Fort, is a factory of Aſia belonging to the Eaſt-India Company, ſeated on one of the branches of the river Ganges, in the kingdom of Bengal. The fort was firſt built in the ſhape of an irregular tetragon of brick and mortar; and the town has nothing regular in it, becauſe every one built a houſe as he liked beſt, and for his own conveniency. The governor's houſe is within the fort, and is the beſt piece of architecture in theſe parts. Here there are alſo convenient lodgings for the factors and writers, with ſtore-houſes for the company's goods, and magazines for ammunition. About 50 yards from the fort is the church, which was originally built by the merchants. The town of *Calcutta* is contiguous, containing 500,000 inhabitants. It is governed by a mayor and aldermen, as moſt of the company's factories in the Eaſt Indies now are. In 1757 it was ſurpriſed by the nabob of Bengal, who took it, and put moſt of thoſe that had made reſiſtance into a place called the *Black-Hole*, where the greater number was ſuffocated. This nabob was afterwards killed, and another ſet up in his room, more friendly to the Engliſh; and the factory was re-eſtabliſhed. E. Long. 86. 0. N. Lat. 22. 27. See CALCUTTA.

Sweet-WILLIAM. See DIANTHUS, BOTANY *Index.*

WILLIAMSBURG, a town of North America, in Virginia, and formerly capital of that ſtate. It is ſituated between two creeks; one falling into James and the other into York River. The diſtance of each landing place is about a mile from the town, which, with the diſadvantage of not being able to bring up large veſſels, and the want of enterpriſe in the inhabitants, has occaſioned its decay. Here is a college, deſigned for the education of the Indians, but which, on account of their averſion to learning, never anſwered the purpoſe. It is 60 miles eaſt of Richmond. W. Long. 76. 30. N. Lat. 37. 10.

WILLIAMSTADT, a ſea-port town of Holland. It is a handſome ſtrong place, and the harbour is well frequented. It was built by William prince of Orange in 1585; and in 1732 belonged to the ſtadtholder of Frieſland. The river near which it is built is called *Butterfliet* or *Holland Diep;* and is one of the bulwarks of the Dutch on the ſide of Brabant, where they always keep a garriſon. This place made a gallant defence in 1793 againſt the French, who were obliged to raiſe the ſiege. It is 15 miles north-eaſt of Bergen-op-Zoom, and 12 ſouth-weſt of Dort. E. Long. 4. 30. N. Lat. 51. 39.

WILLIS, Dr Thomas, a celebrated Engliſh phyſician, was born at Great Bodwin, in Wiltſhire, in 1621, and ſtudied at Chriſt-church college, Oxford. When that city was garriſoned for the king, he, among other ſcholars, bore arms for his majeſty, and devoted his leiſure hours to the ſtudy of phyſic. The garriſon of Oxford at length ſurrendering to the parliament, he applied himſelf to the practice of his profeſſion; and ſoon rendered himſelf famous by his care and ſkill. He appropriated a room as an oratory for divine ſervice according to the church of England, whither moſt of the loyaliſts in Oxford daily reſorted. In 1660, he became Sedleian profeſſor of natural philoſophy, and the ſame year took the degree of doctor of phyſic. In 1664, he diſcovered the famous medicinal ſpring at Alſtropp, near Brackley. He was one of the firſt members of the Royal Society, and ſoon made his name illuſtrious by his excellent writings. In 1666, after the fire of London, he removed to Weſtminſter; and his practice became greater than that of any of the phyſicians his contemporaries. Soon after his ſettlement in London, his only ſon Thomas falling into a conſumption, he ſent him to Montpelier in France for the recovery of his health; and it proved ſucceſsful. His wife alſo labouring under the ſame diſorder, he offered to leave the town; but ſhe, not ſuffering him to neglect the means of providing for his family, died in 1670. He died at his houſe in St Martin's in 1675, and was buried near her in Weſtminſter-abbey. Dr Willis was extremely modeſt and unambitious, and refuſed the honour of knighthood. He was remarkably pious: As he roſe early in the morning, that he might be preſent at divine ſervice, which he conſtantly frequented before he viſited his patients, he procured prayers to be read beyond the accuſtomed times while he lived; and at his death ſettled a ſtipend of 20l. per annum to continue them. He was a liberal benefactor to the poor wherever he came, having from his early practice allotted part of his profits to charitable uſes. He was exact and regular in all his hours: and though his table was the reſort of moſt of the great men of London, yet he was remarkable for his plainneſs, and his being a man of little diſcourſe, complaiſance, or ſociety; but he was juſtly admired for his deep inſight into natural and experimental philoſophy, anatomy, and chemiſtry; for his ſucceſsful practice; and for the elegance and purity of his Latin ſtyle. He wrote, 1. A treatiſe in Engliſh, intitled *A plain and eaſy Method for preſerving thoſe that are well from the Infection of the Plague, and for curing ſuch as are infected.* 2. Several Latin works, which were collected and printed at Amſterdam, in 1682, in 2 vols 4to.

WILLUGHBY, Francis, a celebrated natural hiſtorian, was the only ſon of Sir Francis Willughby, knight. He was fond of ſtudy from his childhood, and held idleneſs in abhorrence; he being ſo great an economiſt with regard to his time, as not willingly to loſe or miſapply the leaſt part of it, by which means he attained great ſkill in all branches of learning, and particularly in the mathematics. But to the hiſtory of animals, which was in a great meaſure neglected by his countrymen, he particularly applied himſelf; and for this purpoſe carefully read over what had been written on that ſubject by others. He then travelled ſeveral times over his native country; and afterwards into France, Spain, Italy, Germany, and the Low Countries, attended by his ingenious friend Mr John Ray. It is remarkable, that, notwithſtanding the advantages of birth, fortune, and parts, he was as humble as any man of the meaneſt fortune; was ſober, temperate, and chaſte; ſcrupulouſly juſt; ſo true to his word and promiſe, that a man might venture his eſtate and life upon it; ſo faithful and conſtant to his friend, as never to deſert him when fortune frowned upon him; and remarkably pious, patient, and ſubmiſſive to the divine will. This is the character given of him by Mr Ray, whoſe veracity none will doubt. This ingenious and learned gentleman died in 1672, at 37 years of age; having impaired his health by his application. He wrote, 1. *Ornithologiæ libri tres*, folio, which was afterwards tranſlated into Engliſh, with an Appendix, by Mr Ray, in folio. 2. *Hiſtoriæ Piſcium libri quatuor*, folio. 3. Letters of Francis Willughby, Eſq. added to Philoſophical Letters between the learned Mr Ray and ſeveral of his correſpondents, publiſhed, in 8vo, by William Derham. 4. Several ingenious papers in the Philoſophical Tranſactions.

WILMOT, John, earl of Rocheſter, a great wit in the reign of Charles II. the ſon of Henry earl of Rocheſter, was born in 1648. He was taught grammar and claſſical learning at the free-ſchool at Burford;

Wilmot.

where he obtained a quick reliſh of the beauties of the Latin tongue, and afterwards became well verſed in the authors of the Auguſtan age. In 1659, he was admitted a nobleman of Wadham college, where he obtained the degree of maſter of arts. He afterwards travelled through France and Italy; and at his return was made one of the gentlemen of the bedchamber to the king, and comptroller of Woodſtock Park. In 1665, he went to ſea, and was in the Revenge, commanded by Sir Thomas Tiddiman, when an attack was made on the port of Bergen in Norway: during the whole action he ſhowed the greateſt reſolution, and gained a high reputation for courage; which he ſupported in a ſecond expedition, but afterwards loſt it in a private adventure with Lord Mulgrave.

Before the earl of Rocheſter travelled, he had indulged in the moſt diſorderly and intemperate way of living; at his return, however, he ſeemed to have got the better of it entirely. But falling into the company of the courtiers, who continually practiſed theſe exceſſes, he became ſo ſunk in debauchery, that he was for five years together ſo given up to drinking, that during all that time he was never cool enough to be maſter of himſelf. His violent love of pleaſure, and his diſpoſition to extravagant mirth, carried him to great exceſſes. The firſt involved him in ſenſuality, and the other led him into many adventures and ridiculous frolics. Once diſguiſing himſelf ſo that he could not be known by his neareſt friends, he ſet up in Tower-ſtreet for an Italian mountebank, and there diſperſed his noſtrums for ſome weeks. He often diſguiſed himſelf as a porter, or as a beggar, ſometimes to follow a mean amour; at other times, he would go about merely for diverſion, in odd ſhapes; and acted his part ſo naturally, that he could not be known even by his friends. In ſhort, by his conſtant indulgence in wine, women, and irregular frolics, he entirely wore out an excellent conſtitution before he was 30 years of age. In October 1679, when recovering from a violent diſeaſe, which ended in a conſumption, he was viſited by Dr Burnet, upon an intimation that ſuch a viſit would be agreeable to him. Dr Burnet publiſhed an account of his conferences with Lord Rocheſter; in which it appears, that though he had lived the life of a libertine and atheiſt, yet he died the death of a penitent Chriſtian. His death happened in 1680; ſince which time his poems have been various times printed, both ſeparately and together: but when once he obtained the character of a lewd and obſcene writer, every thing in that ſtrain was aſcribed to him; and thus many pieces not of his writing have crept into the later editions of his works. The author of the Catalogue of Royal and Noble Authors ſays, he was "a man whom the Muſes were fond to inſpire, and aſhamed to avow, and who practiſed without the leaſt reſerve that ſecret which can make verſes more read for their defects than their merits. Lord Rocheſter's Poems have much more obſcenity than wit, more wit than poetry, and more poetry than politeneſs." His writings, beſides thoſe already mentioned, are, A Satire againſt Mankind; Nothing, a poem; Valentinian, a tragedy; Fifty-four Letters to Henry Saville, and others; Seven more to his Wife and Son: a Letter on his deathbed to Dr Burnet. He alſo left behind him ſeveral other papers, and a Hiſtory of the Intrigues of the Court of Charles II.; but his mother, a very devout lady, ordered all his papers to be burned.

Wilſon.

WILSON, Florence, known in the republic of letters by the name of *Florentius Voluſinus*, was born at Elgin in the ſhire of Murray in Scotland, and educated in the univerſity of Aberdeen. Travelling to England with an intention to improve his fortune, he had the felicity to be introduced to Cardinal Wolſey, who appointed him tutor to one of his nephews. In that capacity he went to Paris, and continued there till the cardinal's death. During his reſidence in that city he became acquainted with the learned Cardinal Bellai, archbiſhop of Paris, who allowed him a penſion, and meant to have appointed him royal profeſſor of the Greek and Latin languages in the univerſity of Paris: but Bellai being diſgraced, Wilſon's proſpects faded with the fortunes of his patron, whom nevertheleſs he attended on his journey to Rome. Wilſon was taken ill at Avignon, and the cardinal proceeded without him. After his recovery, he paid a viſit to the celebrated Cardinal Sabolet, the Mecænas of his time, who was alſo biſhop of Carpentras, where he then reſided. The cardinal was ſo charmed with his erudition, that he appointed him profeſſor of the learned languages, with a ſtipend of 100 piſtoles per annum.

During his reſidence at Carpentras, he wrote his celebrated treatiſe *De Animi Tranquillitate*. Mackenzie ſays that he afterwards taught philoſophy in Italy; and that, being at length deſirous of returning to Scotland, he began his journey homeward, was taken ill at Vienne in Dauphiny, and died there in the year 1547. He was generally eſteemed an accompliſhed linguiſt, an admirable philoſopher, and an excellent Latin poet. He wrote, beſide the above treatiſe, 1. *Poemata*, London 1619, 4to. 2. *Commentatio quædam theologica in aphoriſmos diſſecta, per Sebaſt. Gryph.* 3. *Philoſophiæ Ariſtot. Synopſis*, lib. iv.

WILSON, *Thomas*, lord biſhop of Sodor and Man, was born in 1663, at Burton, in the county of Cheſter. He received the rudiments of his education at the county town, and from thence was removed to the univerſity of Dublin. His allowance at the univerſity was 20l. a-year; a ſum, ſmall as it may now appear, which was in thoſe days ſufficient for a ſober youth in ſo cheap a country as Ireland.

His firſt intention was to have applied to the ſtudy of phyſic; but from this he was diverted by Archdeacon Hewetſon, by whoſe advice he dedicated himſelf to the church. He continued at college till the year 1686, when, on the 29th of June, he was ordained deacon.

The exact time of Mr Wilſon's leaving Dublin is not known: but on account of the political and religious diſputes of thoſe days, it was ſooner than he intended. On the 10th of December, in the ſame year, he was licenſed to the curacy of New Church in Winwick, of which Dr Sherlock, his maternal uncle, was rector. His ſtipend was no more than 30l. a-year; but being an excellent economiſt, and having the advantage of living with his uncle, this ſmall income was not only ſufficient to ſupply his own wants, but it enabled him to ſupply the wants of others; and for this purpoſe he ſet apart one-tenth of his income. In 1692 he was appointed domeſtic chaplain to William earl of Derby, and tutor to his ſon James Lord Strange, with a ſalary of 30l. a-year. He was ſoon after elected maſter of the alms-houſe at Latham, which brought him in 20l. a-year more. Having now an income far beyond his expectations, or his wiſhes, except as it increaſed his ability to do good, he ſet apart one-fifth of his income for pious uſes, and particularly for the poor. In ſhort, as his income increaſed, he increaſed the portion of it which was allotted to the purpoſes of charity. At firſt he ſet apart a tenth, then a fifth, afterwards a third, and laſtly, when he became a biſhop, he dedicated the full half of his revenues to pious and charitable uſes.

He had not been long in the ſervice of Lord Derby, before he was offered the valuable living of Buddeſworth in Yorkſhire; which he refuſed to accept, as being inconſiſtent with the reſolves of his conſcience againſt non-reſidence, Lord Derby chooſing ſtill to retain him as chaplain and tutor to his ſon. In 1697 he was promoted, not without ſome degree of compulſion on the part of his patron, to the biſhopric of the Iſle of Man; a preferment which he held 58 years. In 1698 he married Mary, daughter of Thomas Patten, Eſq. of Warrington. By this lady, who ſurvived her marriage about ſix years, he had four children; none of whom ſurvived him except the late Dr Wilſon, prebendary of Weſtminſter.

“ The annual receipts of the biſhopric (ſays the author of his memoirs) did not exceed 300l. in money. Some neceſſaries in his houſe, as ſpices, ſugar, wine, books, &c. muſt be paid for with money; diſtreſſed or ſhipwrecked mariners, and ſome other poor objects, required to be relieved with money; but the poor of the iſland were fed and clothed, and the houſe in general ſupplied from his demeſnes, by exchange, without money. The poor, who could weave or ſpin, found the beſt market at Biſhop's-court, where they bartered the produce of their labour for corn. Taylors and ſhoemakers were kept in the houſe conſtantly employed, to make into garments or ſhoes that cloth or leather which his corn had purchaſed; and the aged and infirm were ſupplied according to their ſeveral wants. Mr Moore of Douglas informed the editor, that he was once witneſs to a pleaſing and ſingular inſtance of the Biſhop's attention to ſome aged poor of the iſland. As he was diſtributing ſpectacles to ſome whoſe eyeſight failed them, Mr Moore expreſſed his ſurpriſe, as he well knew not one of them could read a letter. ‘ No matter (ſaid the Biſhop with a ſmile), they will find uſe enough for them; theſe ſpectacles will help them to thread a needle, to mend their clothes, or, if need be, to keep themſelves free from vermin.’

So great was the biſhop's attachment to his flock, that no temptation could ſeduce him from their ſervice. He more than once refuſed the offer of an Engliſh biſhopric. There is an anecdote of his lordſhip and Cardinal Fleury, which does great credit to them both. The cardinal wanted much to ſee him, and ſent over on purpoſe to inquire after his health, his age, and the date of his conſecration, as they were the two oldeſt biſhops, and he believed the pooreſt, in Europe; at the ſame time inviting him to France. The biſhop ſent the cardinal an anſwer, which gave him ſo high an opinion of him, that the cardinal obtained an order that no French privateer ſhould ravage the iſle of Man.

This good prelate lived till the year 1755, dying at the advanced age of 93. His works have lately been publiſhed in 2 vols 4to.

WILTON, a market town in Wiltſhire, three miles weſt of Saliſbury. It was once ſo conſiderable as to give title to the county. It formerly had 12 churches; and Odo, brother-in-law to William I. was biſhop of Wilton. Only one now remains. It ſends members to parliament, and is the place where the knights of the ſhire are choſen. It has a great manufactory of carpets, which are brought to high perfection. Wilton is famous for Lord Pembroke's ſeat, ſo well known through Europe for its containing a grand aſſemblage of the productions of the greateſt and moſt ancient maſters in painting and ſculpture.—Two fairs are held here annually.

WILTSHIRE, a county of England, bounded on the weſt by Somerſetſhire, on the eaſt by Berkſhire and Hampſhire, on the north by Glouceſterſhire, and on the ſouth by Dorſetſhire and part of Hampſhire. The length amounts to 39 miles; its breadth to 30; and its circumference to 140. It contains 29 hundreds, 23 market-towns, 304 pariſhes, and about 185,107 ſouls. Beſides two members for the ſhire, and two for the city of Saliſbury, each of the following towns ſends two members to parliament, viz. Wilton, Downton, Hindon, Heyteſbury, Weſtbury, Calne, Devizes, Chippanham, Malmſbury, Cricklade, Great Bedwin, Ludgerſhall, Old Sarum, Wooton-Baſſet, Marlborough.

The air of this county is very healthy, not only in the more low and level parts, but alſo on the hills. The ſoil of the vales is very rich, and produces corn and graſs in great plenty. The beautiful downs in the ſouth yield the fineſt paſture for ſheep, with which they are overſpread. The greateſt diſadvantage the county labours under is want of fuel, as there are no coal-pits, and but little wood. This county is noted for great quantities of very fine cheeſe, and for its manufacture of broad cloth, to which it was invited by the great plenty and fineneſs of its wool. Beſides a number of leſſer ſtreams, it is watered by the rivers Iſis, Kennet, Upper and Lower Avon, Willy, Burne, and Nadder, which are well ſtored with fiſh.

WINCHELSEA, a town in Suſſex, which has no market, but has one fair on May 14th for cattle and pedlars ware. It was an ancient place, at leaſt the old town, which was ſwallowed up by the ocean in 1250. It is now dwindled to a mean place, though it retains its privileges, and ſends two members to parliament. It is ſeated on a rocky cliff, on an inlet of the ſea; and had a haven, now choked up. It had 18 pariſh-churches, now reduced to one. The market-houſe is in the midſt of the town, from whence run four paved ſtreets, at the end of which are four ways, which had formerly buildings on each ſide for a conſiderable diſtance. It is two miles ſouth-weſt of Rye, and 71 ſouth-eaſt of London. It is governed by a mayor and jurats, though it has but about 70 houſes. Three of the gates are ſtill ſtanding, but much decayed. E. Long. 0. 44. N. Lat. 50. 58.

WINCHELSEA, *Anne Counteſs of*, a lady of excellent genius, eſpecially in poetry, was maid of honour to the ducheſs of York, ſecond wife to King James II. and was afterwards married to Heneage, ſecond ſon of the earl of Winchelſea. One of the moſt conſiderable of the counteſs of Winchelſea's poems was that on the

Spleen. A collection of her poems was printed at London in 1713, containing a tragedy never acted, intitled *Ariſtomenes*. The counteſs died in 1720 without iſſue, as her huſband did in 1726.

WINCHESTER, the capital of the county of Hampſhire in England. It is a very ancient city, ſuppoſed to have been built ſeveral centuries before Chriſt. The Romans called it *Venta Belgarum*, the Britons *Caer Givent*, and the Saxons *Wittanceaſter;* whence came the preſent name. It ſtands upon the river Itchin, in a bottom ſurrounded with chalky hills; and is generally allowed to have been a conſiderable place in the time of the Romans. Some of the firſt converts to Chriſtianity are ſuppoſed to have lived here. In the caſtle, near the weſt gate, many of the Saxon kings anciently kept their court. The cathedral was founded by Kenegulſe, a king of the Mercians; but there were many Chriſtians, and places for their worſhip here, long before that period. It is a large pile, and has a venerable look, but is not very elegant. Beſides the tombs, there are many curious pieces of workmanſhip in it; the chief of which are, 1. The font, erected in the time of the Saxons. 2. Copper ſtatues of James I. and Charles I. 3. The biſhop's throne. 4. The ſtalls of the dean and prebendaries. 5. The aſcent to the choir and altar. 6. The pavement, inlaid with marble of diverſe colours, in various figures. 7. The altar-piece, reckoned the nobleſt in England. 8. The paintings in the windows, eſpecially the great eaſt window. At the hoſpital of the Holy Croſs, every traveller that knocks at the door may claim a manchet of white bread and a cup of beer; of which a great quantity is provided every day for that purpoſe. This hoſpital was intended for the maintenance of a maſter and 30 penſioners, but only 14 are now maintained in it; and the maſter enjoys a revenue of 800l. a-year. This city is about a mile and a half in compaſs, and almoſt ſurrounded with a wall of flint; has ſix gates, large ſuburbs, broad clean ſtreets; but the private houſes are in general but ordinary, many of them being very old. The city is interſperſed with a great many gardens, which contribute to its beauty and healthineſs. The corporation conſiſts of a mayor, high-ſteward, recorder, aldermen, two coroners, two bailiffs, 24 common-council men, a town clerk, four conſtables, and four ſerjeants at mace; and the city gives title of *marquis* to the duke of Bolton. A Roman highway leads from hence to Alton; and went formerly, as it is thought, from thence to London. The charming downs in the neighbourhood contribute greatly to the health and pleaſure of the inhabitants. The river Itchin is navigable for barges from hence to Southampton. W. Long. 1. 21. N. Lat. 51. 5.

WINCKLEMAN, Abbe John, was born at Stendall, in the old Marche of Brandenburg, in 1718. His father was a ſhoemaker. This wonderful man, to all appearance deſtined by his birth to ſuperintend a little ſchool in an obſcure town of Germany, raiſed himſelf to the office of preſident of antiquities in the Vatican. After having been ſeven years profeſſor in the college of Seehauſen near Salſwedel, he went into Saxony, where he reſided ſeven years more, and was librarian to Count Bunau at Nothenitz. When he left this place, 1754, he went to Dreſden, where he formed an acquaintance with the ableſt artiſts, and particularly with M. Oeſer, an excellent painter, and one of the beſt draughtſmen of the age. In that year he abjured Lutheraniſm, and embraced the Roman Catholic religion. In September 1755, he ſet out for Italy, and arrived at Rome in December following. His principal object was to ſee the Vatican library, and to examine the ruins of Herculaneum.

Mr Winckleman carried with him into Italy a ſenſe of beauty and art, which led him inſtantly to admire the maſterpieces of the Vatican, and with which he began to ſtudy them. He ſoon increaſed his knowledge; and it was not till after he had thus purified his taſte and conceived an idea of ideal beauty, which led him into the greateſt ſecrets of art, that he began to think of the explanation of other monuments, in which his great learning could not fail to diſtinguiſh him. His erudition enabled him to fill up his principal plan of writing the "Hiſtory of Art." In 1756 he planned his "Reſtoration of Ancient Statues," and a larger work on the Taſte of the Greek Artiſts; and deſigned an account of the galleries of Rome and Italy, beginning with a volume on the Belvidere ſtatues, in the manner of Richardſon, who, he ſays, only ran over Rome. He alſo intended a hiſtory of the corruption of taſte in art, the reſtoration of ſtatues, and an illuſtration of the obſcure points of mythology. All theſe different eſſays led him to his "Hiſtory of Art," and his "Monumenti Inediti." It muſt, however, be confeſſed, that the firſt of theſe works has not all the clearneſs and preciſion that might be expected in its general plan and diviſion of its parts and objects; but it has enlarged and extended the ideas both of antiquaries and collectors. The deſcription of the gems and ſulphurs of the Stoſch cabinet contributed not a little to extend Mr Winckleman's knowledge. Few perſons have opportunities of contemplating ſuch vaſt collections. The engravings of Lippet and Count Caylus are all that many can arrive at. Mr Winckleman's Monumenti Inediti, of which he had begun the third volume 1767, ſeem to have ſecured him the eſteem of antiquaries. Had he lived, we ſhould have had a work long wiſhed for; a complete collection of the basreliefs diſcovered from the time of Bartoli to the preſent, the greater part of which are in the poſſeſſion of Cardinal Albani.

When Cardinal Albani ſucceeded to the place of librarian of the Vatican, he endeavoured to get a place for the Hebrew language for Winckleman, who refuſed a canonry, becauſe he would not take the tonſure. The elector of Saxony gave him, 1761, unſolicited, the place of Counſellor Richter, the direction of the royal cabinet of medals and antiquities at Dreſden. Upon the death of the abbé Venuti, 1762, he was appointed preſident of the antiquities of the apoſtolic-chamber, with power over all diſcoveries and exportations of antiquities and pictures. This is a poſt of honour, with an income of 160 ſcudi per annum. He had a proſpect of the place of preſident of antiquities in the Vatican, going to be created at 16 ſcudi per month, and was named correſponding member of the Academy of Inſcriptions. The king of Pruſſia offered him, by Col. Quintus Icilius, the place of librarian and director of his cabinet of medals and antiquities, void by the death of M. Gautier de la Croze, with a handſome appointment. He made no ſcruple of accepting the offer; but when it came to the pope's ears, he added an appointment out of his own purſe, and kept him at Rome.

In April 1768, he left Rome to go with M. Cavaceppi over Germany and Switzerland. When he came to Vienna, he was ſo pleaſed with the reception he met with, that he made a longer ſtay there than he had intended. But, being ſuddenly ſeized with a ſecret uneaſineſs and extraordinary deſire to return to Rome, he ſet out for Italy, putting off his viſits to his friends in Germany to a future opportunity. As he paſſed through Trieſte, he was aſſaſſinated, June 8. 1768, by a wretch named Arcangeli, a native of Campiglio, a town in the territory of Piſtoia, with whom he had made an acquaintance on the road. This miſcreant had been condemned for a robbery to work in fetters four years, and then to be baniſhed the Auſtrian territories, on an oath never to return. He had obtained a mitigation of one of his ſentences, and retired to Venice; but, changing his quarters backwards and forwards, he was ſo reduced in circumſtances that he at length took up his lodgings at the inn to which the Abbé happened to come. Arcangeli paid ſuch aſſiduous court to him, that he entirely gained his confidence; and having been favoured with a ſight of the valuable preſents which he had received at Vienna, formed a deſign to murder and rob him. He bought a new ſharp knife on purpoſe; and as the Abbé (who had in the moſt friendly manner invited him to Rome) was ſitting down in his chair, early in the morning, he threw a rope over his head, and before he could diſengage himſelf, ſtabbed him in five different places. The Abbé had ſtill ſtrength to get down to the ground floor, and call for help; and being laid on a bed in the midſt of the moſt violent pain, he had compoſure ſufficient to receive the laſt ſacraments, and to make his will, in which he appointed Cardinal Alexander Albani his reſiduary legatee, and expired in the afternoon. The murderer was ſoon after apprehended; and executed on the wheel oppoſite the inn, June 26.

Abbé Winckleman was a middle-ſized man; he had a very low forehead, ſharp noſe, and little black hollow eyes, which gave him an aſpect rather gloomy than otherwiſe. If he had any thing graceful in his phyſiognomy, it was his mouth. A fiery and impetuous diſpoſition often threw him into extremes. Naturally enthuſiaſtic, he often indulged an extravagant imagination; but as he poſſeſſed a ſtrong and ſolid judgement, he knew how to give things a juſt and intrinſic value. In conſequence of this turn of mind, as well as a neglected education, a cautious reſerve was a quality he little knew. If he was bold in his deciſions as an author, he was ſtill more ſo in his converſation, and has often made his friends tremble for his temerity. If ever man knew what friendſhip was, that man was Mr Winckleman, who regularly practiſed all his duties; and for this reaſon he could boaſt of having friends among perſons of every rank and condition.

WIND is a ſenſible agitation of the atmoſphere, occaſioned by a quantity of air flowing from one place to another. See METEOROLOGY.

Hot WINDS. See SAMIEL.

WIND-Flower. See ANEMONY, BOTANY *Index.*

WIND-Mill, a kind of mill, the internal parts of which are much the ſame with thoſe of a water mill: from which, however, it differs, in being moved by the impulſe of the wind upon its ſails or vanes, which are to be conſidered as a wheel in axis. See MECHANICS *Index.*

WIND-Gage. See *Wind-GAGE.*

WIND-Galls. See FARRIERY *Index.*

WIND-Gun. See *AIR-GUN*, under *SCIENCE*, *Amuſements of.*

Inſtruments for meaſuring the ſtrength, velocity, &c. *of the WIND.* See *Wind-GAGE*, ANEMOMETER and ANEMOSCOPE.

WIND-Hatch, in mining, a term uſed to expreſs the place at which the ore is taken out of the mines.

WIND-Shock, a name given by our farmers to a diſtemper to which fruit trees, and ſometimes timber trees, are ſubject. It is a ſort of bruiſe and ſhiver throughout the whole ſubſtance of the tree; but the bark being often not affected by it, it is not ſeen on the outſide, while the inſide is twiſted round, and greatly injured. It is by ſome ſuppoſed to be occaſioned by high winds; but othes attribute it to lightning. Thoſe trees are moſt uſually affected by it whoſe boughs grow more out on one ſide than on the other. The beſt way of preventing this in valuable trees, is to take care in the plantation that they are ſheltered well, and to cut them frequently in a regular manner while young.

WIND-Taught, in ſea language, denotes the ſame as ſtiff in the wind. Too much rigging, high maſts, or any thing catching or holding wind aloft, is ſaid to hold a ſhip wind-taught; by which they mean, that ſhe ſtoops too much in her ſailing in a ſtiff gale of wind. Again, when a ſhip rides in a main ſtreſs of wind and weather, they ſtrike down her top-maſts, and bring her yards down, which elſe would hold too much wind, or be too much diſtended and wind-taught.

WIND-Sails, a ſort of wide tube or funnel of canvas, employed to convey a ſtream of freſh air downward into the lower apartments of a ſhip.

This machine is uſually extended by large hoops ſituated in different parts of its height. It is let down perpendicularly through the hatches, being expanded at the lower end like the baſe of a cone; and having its upper ſide open on the ſide which is placed to windward, ſo as to receive the full current of wind; which entering the cavity, fills the tube, and ruſhes downwards into the lower regions of the ſhip. There are generally three or four of theſe in our capital ſhips of war, which, together with the ventilators, contribute greatly to preſerve the health of the crew.

WINDAGE *of a GUN*, is the difference between the diameter of the bore and the diameter of the ball.

WINDLASS, a machine uſed for raiſing huge weights, as guns, ſtones, anchors, &c.

It is very ſimple, conſiſting only of an axis or roller, ſupported horizontally at the two ends by two pieces of wood and a pulley; the two pieces of wood meet at top, being paced diagonally ſo as to prop each other; the axis or roller goes through the two pieces, and turns in them. The pulley is faſtened at top where the pieces join. Laſtly, there are two ſtaves or handſpikes which go through the roller, whereby it is turned, and the rope which comes over the pulley is wound off and on the ſame.

WINDLASS, in a ſhip, is an inſtrument in ſmall ſhips, placed upon the deck, juſt abaft the fore-maſt. It is made of a piece of timber ſix or eight feet ſquare, in form of an axletree, whoſe length is placed horizontally upon two pieces of wood at the ends thereof, and upon which it is turned about by the help of handſpikes put into holes made for that purpoſe. This inſtrument ſerves for weighing anchors, or hoiſting of any weight in or out of the ſhip, and will purchaſe much more than any capſtan, and that without any danger to thoſe that heave; for if in heaving the windlaſs about, any of the handſpikes ſhould happen to break, the windlaſs would pall of itſelf.

WINDOW, an aperture or open place in the wall of a houſe to let in the light. See ARCHITECTURE, N° 78.

The word is Welch, *uynt dor*, ſignifying the paſſage for the wind. Window is yet provincially denominated *windor* in Lancaſhire; i. e. *wind-door*, or the paſſage for air, as that for people was peculiarly called the *door*.

Before the uſe of glaſs became general, which was not till towards the end of the 12th century, the windows in Britain ſeem generally to have been compoſed of paper. Properly prepared with oil, this forms no contemptible defence againſt the intruſions of the weather, and makes no incompetent opening for the admiſſion of the light. It is ſtill uſed by our architects for the temporary windows of unfiniſhed houſes, and not unfrequently for the regular ones of our work ſhops. But ſome of the principal buildings we may reaſonably ſuppoſe to have been windowed in a ſuperior manner. They could, however, be furniſhed merely with lattices of wood or ſheets of linen, as theſe two remained the only furniture of our cathedrals nearly to the eighth century; and the lattices continued in ſome of the meaner towns of Lancaſhire to the 18th; and in many diſtricts of Wales, and many of the adjoining parts of England, are in uſe even to the preſent moment. Theſe ſeem all to have been fixed in frames that were called *capſamenta*, and now therefore *caſements* in Wales and Lancaſhire.

WINDSOR, a borough town of Berkſhire, 22 miles weſt of London, moſt remarkable for the magnificent royal palace or caſtle ſituated there on an eminence, which commands the adjacent country for many miles, the river Thames running at the foot of the hill. The knights of the garter are inſtalled in the royal chapel here. It ſends two members to parliament. W. Long. 0. 36. N. Lat. 51. 30.

WINDWARD, in the ſea language, denotes any thing towards that point from whence the wind blows, in reſpect of a ſhip: thus windward-tide, is the tide which runs againſt the wind.

WINE, an agreeable ſpirituous liquor, produced by fermentation from thoſe vegetable ſubſtances that contain ſaccharine matter. A very great number of vegetable ſubſtances may be made to afford wine, as grapes, currants, mulberries, elders, cherries, apples, pulſe, beans, peas, turnips, radiſhes, and even graſs itſelf. Hence, under the claſs of wines or vinous liquors, come not only wines, abſolutely ſo called, but alſo ale, cyder, &c.

Chaptal's Chemiſtry, part iv. ſect. v. chap. 6.

1
Method of making wine.

Wine, however, is in a more particular manner appropriated to the liquor drawn from the fruit of the vine. The proceſs of making wine is as follows: When the grapes are ripe, and the ſaccharine principle is developed, they are then preſſed, and the juice which flows out is received in veſſels of a proper capacity, in which the fermentation appears, and proceeds in the following manner: At the end of ſeveral days, and frequently after a few hours, according to the heat of the atmoſphere, the nature of the grapes, the quantity of the liquid, and temperature of the place in which the operation is performed, a movement is produced in the liquor, which continually increaſes; the volume of the fluid increaſes; it becomes turbid and oily; carbonic acid is diſengaged, which fills all the unoccupied part of the veſſel, and the temperature riſes to the 72.5th degree. At the end of ſeveral days theſe tumultuous motions ſubſide, the maſs falls, the liquid becomes clearer, and is found to be leſs ſaccharine, more odorant, and of a red colour, from the reaction of the ardent ſpirit upon the colouring matter of pellicle of the grape.

The wine is uſually taken out of the fermenting veſſels at the period when all the phenomena of fermentation have ſubſided. When the maſs is ſettled, the colour of the liquor is well developed, when it has become clear, and its heat has diſappeared; it is put into caſks, where, by a ſecond inſenſible fermentation, the wine is clarified, its principles combine more perfectly together, and its taſte and ſmell become more and more developed. If this fermentation be ſtopped or ſuffocated, the gaſeous principles are retained, and the wine is briſker, and more of the nature of muſt.

It appears, from the intereſting experiments of the Marquis de Bullion, that the vinous fermentation does not take place unleſs tartar be preſent.

2
Cauſes of imperfect fermentation.

The cauſes of an imperfect fermentation are the following: 1. If the heat be too little, the fermentation languiſhes, the ſaccharine and oily matters are not ſufficiently elaborated, and the wine is unctuous and ſweet. 2. If the ſaccharine body be not ſufficiently abundant, as happens in rainy ſeaſons, the wine is weak, and the mucilage, which predominates, cauſes it to become ſour by its decompoſition. 3. If the juice be too watery, concentrated and boiling muſt is added. 4. If the ſaccharine principle be not ſufficiently abundant, the defect may be remedied by the addition of ſugar. Macquer has proved that excellent wine may be made of verjuice and ſugar; and M. de Bullion has made wine at Bellejames, with the verjuice of his vine rows and moiſt ſugar.

There have been many diſputes to determine whether grapes ſhould be preſſed with the ſtalks or without. This depends on the nature of the fruit. When they are highly charged with ſaccharine and mucilaginous matter, the ſtalk corrects the inſipidity of the wine by its bitter principle: but when, on the contrary, the juice is not too ſweet, the ſtalk renders it drier, and very rough.

3
Colouring matter of wine.

The colouring principle of wine is of a reſinous nature, and is contained in the pellicle of the grape; and the fluid is not coloured until the wine is formed; for until then there is nothing which can diſſolve it: and hence it is that white wine may be made of red grapes, when the juice of the grape is expreſſed, and the huſk thrown away. If wine be evaporated, the colouring principle remains in the reſidue, and may be extracted by ſpirit of wine. Old wines loſe their colour; a pellicle being precipitated, which is either depoſited on the ſides of the bottles, or falls to the bottom. If wine be expoſed to the heat of the ſun during the ſummer, the colouring matter is detached in a pellicle, which falls to the bottom: when the veſſel is opened, the diſcolouring is is more ſpeedy, and it is effected in two or three days during the ſummer. The wine thus deprived of its colour is not perceptibly weakened.

4
Vinous fermentation explained.

The vinous fermentation has been examined with great accuracy by M. Lavoiſier. According to him, the vegetable juice of which wine is to be made conſiſts of oxygen, hydrogen, and carbone, combined with one another in different proportions, ſo as to form chiefly water and ſugar. The fermentation produces a ſeparation of the elements, and a new combination of them; a quantity of the oxygen and carbone combine and fly off in the ſtate of carbonic acid; part of the carbone, oxygen, and hydrogen, combine firſt with each other, and then all together, to form alcohol; another part forms acetous acid; the water ſtill remains, and a reſiduum falls to the bottom compoſed of the three elements combined in other proportions.

5
Ingredients in different wines.

The different kinds of wines produced in Europe and other parts of the world are many; the principal of them and their qualities are well known: a catalogue of them would ſerve no purpoſe here. We ſhall, however, ſubjoin a table of the quantities of the ingredients of the principal kinds from Neumann's Chemiſtry.

A quart of	Highly rectified Spirit.			Thick, oily, unctuous, reſinous matter.			Gummy and tartarous matter.			Water.			
	oz.	dr.	gr.	oz.	dr.	gr	oz.	dr.	gr.	lb.	oz.	dr.	gr
Aland	1	6	00	3	2	00	1	5	00	2	5	3	00
Alicant	3	6	00	6	0	20	0	1	40	2	2	6	00
Burgundy	2	2	00	0	4	00	0	1	40	2	9	0	20
Carcaſſone	2	6	00	0	4	10	0	1	20	2	8	4	30
Champagne	2	5	20	0	6	40	0	1	00	2	8	3	00
French	3	0	00	0	6	40	0	1	00	2	8	0	20
Frontignac	3	0	00	3	4	00	0	5	20	2	4	6	30
Vin Grave	2	0	00	0	6	00	0	2	00	2	9	0	00
Hermitage	2	7	00	1	2	00	0	1	40	2	7	5	20
Madeira	2	3	00	3	2	00	2	0	00	2	4	3	00
Malmſey	4	0	00	4	3	00	2	3	00	2	1	2	00
Vino de Monte Pulciano	2	6	00	0	3	00	0	2	40	2	8	0	20
Moſelle	2	2	00	0	4	20	0	1	30	2	9	0	10
Muſcadine	3	0	00	2	4	00	1	0	00	2	5	4	00
Neufschatel	3	2	00	4	0	00	1	7	00	2	2	7	00
Palm Sec	2	3	00	2	4	00	4	4	00	2	2	5	00
Pontac	2	0	00	0	5	20	0	2	00	2	9	0	40
Old Rheniſh	2	0	00	1	0	00	0	2	20	2	8	5	40
Rheniſh	2	2	00	0	3	20	0	1	34	2	9	1	06
Salamanca	3	0	00	3	4	00	2	0	00	2	3	4	00
Sherry	3	0	00	6	0	00	2	2	00	2	0	6	00
Spaniſh	1	2	00	2	4	00	9	4	00	1	10	6	00
Vino Tinto	3	0	00	6	4	00	1	6	00	2	0	6	00
Tokay	2	2	00	4	3	00	5	0	00	2	0	3	00
Tyrol red wine	1	4	00	1	2	00	0	4	00	2	8	6	00
Red wine	1	6	00	0	4	40	0	2	00	2	9	3	20
White	2	0	00	0	7	00	0	3	00	2	7	0	00

The colour of wine is frequently artificial; a deep red is almoſt always the effect of artificial additions, as of the red woods, elder berries, bilberries, &c. In France no ſecret is made of theſe practices, the colouring matters being publicly thrown out after they have been uſed.

6
Adulteration of wine.

It is well known to be a common practice among wine-coopers, innkeepers, and other dealers in wines, to adulterate bad wine in order to conceal its defects: if, for inſtance, the wine be ſour, they throw into it a quantity of ſugar of lead, which entirely takes away the ſour taſte. For ſimilar purpoſes alum is often mixed with wine. Such ſubſtances, however, are well known to be extremely pernicious to the human conſtitution; it becomes of importance therefore to be able to detect them whenever they happen to be contained in wine. Several chemiſts who have turned their attention to this ſubject, have furniſhed us with teſts for this purpoſe.

7
To detect lead in wine.
Watſon's Chemical Eſſays, vol. iii. p. 371.

To diſcover lead diſſolved in wine, boil together in a pint of water an ounce of quicklime and half an ounce of flour of brimſtone; and when the liquor, which will be of a yellow colour, is cold, pour it into a bottle, and cork it up for uſe. A few drops of this liquor being dropt into a glaſs of wine or cyder containing *lead*, will change the whole into a colour more or leſs *brown*, according to the quantity of lead which it contains. If the wine be wholly free from lead, it will be rendered turbid by the liquor, but the colour will be rather a dirty white than a black brown.

By this teſt, however, iron is alſo precipitated when diſſolved in wine, and is apt to be taken for lead; a miſtake which has ruined ſeveral honeſt merchants. The following teſt is therefore preferable, as not liable to the ſame inconvenience.

8
Another method.

Take equal parts of calcined oyſter-ſhells and crude ſulphur in fine powder, and put them in a crucible, which put into a fire, and raiſe the heat ſuddenly till it has been expoſed to a white heat for 15 minutes. Then take it out, let it cool, beat the ingredients to powder, and put them into a well corked bottle. To prepare the teſt liquor, put 20 grains of this powder together with 120 grains of cream of tartar, and put them into a ſtrong bottle, fill it up with water, boil it for an hour, and let it cool. Cork the bottle immediately, and ſhake it from time to time. After ſome hours repoſe, decant off the clear liquor into an ounce vial, having firſt put 22 drops of muriatic acid into each vial. Cork theſe vials accurately with a little wax mixed up with a little turpentine. One part of this liquor, mixed with three parts of ſuſpected wine, will diſcover the preſence of the ſmalleſt quantity of lead or copper, by a very ſenſible black precipitate, and of arſenic by an orange precipitate: but will have no effect on iron, if there be any; the preſence of which, however, may be aſcertained by adding a little potaſh, which will turn the liquor black if there be any iron. Pure wine remains limpid after the addition of this liquor ‡.

‡ *Journal de Phyſique*, October 1791.

9
State of lead in wine.

As this ſubject is of importance, we ſhall add M. Fourcroy's obſervations on the ſtate in which lead exiſts in wine, and on the methods of diſcovering its preſence: "Of the different principles which compoſe wine, there was no doubt (ſays he) but that acids were the only ones which were capable of diſſolving oxide (*calx*) of lead. But was it the tartareous acid always contained in larger or ſmaller quantity in wine, or the acetous acid developed in thoſe which have become ſharp, and which there is a greater temptation to ſweeten? Experiencerience had proved to me that the acidulous tartrate of potaſh, or the cream of tartar, takes oxide of lead from the acetous acid, and a precipitate of tartrate of lead is formed; the pure tartareous acid prepared in Scheele's method produces the ſame effect. In order to underſtand how the ſharp wine which contains theſe two acids can hold the oxide of lead in ſolution, I made the experiments which gave me the following reſults: 1. The acidulous tartrite (*crem. tart.*) has no ſenſible action upon the oxides of lead. 2. The pure tartareous acid has a ſlight action upon the oxides, and forms on their ſurface a little tartrite of lead (*tartariſed lead*), in a white powder. 3. Wine which only contains the tartareous acidule, would not have any action upon the ſemi-vitrous oxide of lead or litharge. 4. Sharp wine which we attempt to ſweeten by this oxide of lead, acts firſt upon it by the acetous acid it contains. 5. When this acetite of lead is formed, the tartareous acid precipitates it in the form of tartrite of lead: this is proved by the precipitate which the ſolution of the acetite of lead or ſugar of lead forms in the wine. 6. But the acetous acid, if it be in large enough quantity, rediſſolves the tartrite of lead in the wine juſt as diſtilled water would. Bergman has pointed out this ſolution of tartrite of lead in acetous acid for diſtinguiſhing the tartareous ſalt from the ſulfat of lead (*vitriol of lead*). 7. As this ſolution of tartrite of lead in the acetous acid is much quicker, and more eaſy in ſharp wines than in diſtilled water and vinegar, it is probable that the cauſe of this difference depends upon the citric and malic acids which I have found in wine, and which I ſhall take notice of again on another occaſion. 8. Litharged wine then, or wine ſweetened with lead, contains tartrite diſſolved in the acetous acid, and perhaps at the ſame time in the malic and citric acids.

10
It forms an aceto-tartrite of lead.

"It was neceſſary afterwards to know the properties of this combination. What experience has taught me is as follows: I particularly examined the tartrite of lead and its ſolution in acetous acid. The tartrite of lead is ſcarcely at all ſoluble in water; it is in the form of powder, or of ſmall white grains which have no ſenſible taſte; when it is diſſolved in vinegar, the vinegar is ſoftened, its ſharpneſs is diminiſhed remarkably, and the ſolution takes a ſlight ſweetiſh taſte, much leſs ſtrong than that of the pure acetite of lead. This taſte proves that the union of the tartrite of lead with vinegar is not only a ſolution like that of ſalt in water, by which the properties of the ſalt are not changed, but a combination which gives occaſion to new properties. It is a kind of a triple ſalt, different from thoſe we have hitherto known, formed of two acids and of one baſe; whereas the other triple ſalts deſcribed hitherto are compoſed of one acid and two baſes. I name this new triple ſalt *aceto-tartrite of lead.* The acetous acid adheres to it more than water in a common ſolution: what is remarkable in this combination is, that the two acids appear to adhere to the baſe with an equal force, although they have a different attraction for it: nothing is neceſſary to produce this equilibrium, but to unite firſt the oxide of lead with the acid to which it adheres the moſt ſtrongly, and afterwards to put this firſt compound in contact with the weaker acid.

11
Other methods of detecting this ſalt.

"It was neceſſary, in order to diſcover eaſy and certain methods of aſcertaining the preſence of lead in wine, to examine with care the properties and phenomena of the decompoſitions of the aceto-tartrite of lead. Fixed alkalies and ammoniac (*volatile alkali*) precipitate from this ſalt an oxide of lead, which is of a grayiſh white colour; but as they occaſion a precipitate in pure wine, they cannot be of any uſe. The ſulphuric (*vitriolic*) acid decompoſes the aceto-tartrite of lead, and forms with it inſtantly ſulphate of lead; which being very little ſoluble, and very heavy, is precipitated. The oxalic, or pure ſaccharine acid, and the acidulous oxalate, or the ſalt of ſorrel of the ſhops, likewiſe decompoſe this ſalt, and take from it the lead. The oxalate of lead is precipitated in great abundance: theſe two acids, the ſulphuric and oxalic acids, not producing any precipitate in pure wine, are very proper to ſhow the preſence of lead in wine. The ſulphate and oxalate of lead, when they are precipitated from wine, are coloured, whereas they are very white when they are formed in diſtilled water; but their red or brown colour does not prevent us from diſcovering them by a very ſimple method. If the precipitates be collected with care, and are cautiouſly heated upon a coal with a blow-pipe, they ſmoke, become white, exhale vapours, paſs ſucceſſively through the ſtates of the red and yellow oxides of lead, and at length are reduced into metallic globules at the inſtant they are perceived to be agitated by a very evident efferveſcence: if we ceaſe to blow at this inſtant, we obtain globules upon the charcoal. In order to this, it is neceſſary, however, that the charcoal be ſolid, and be not cracked, and that we ſhould not have blowed too ſtrongly; otherwiſe the globules would be abſorbed, and would diſappear. The ſulphate of lead requires a longer time to be reduced than the oxalate of the ſame metal, and there is a greater hazard of loſing the metallic particles, which, beſide, are in ſmall quantity.

"To theſe two firſt proceſſes, already ſufficiently certain of themſelves, I wiſhed to be able to add one which might be capable of pointing out inſtantly the preſence of lead, by an appearance belonging excluſively to this metal, and which might unite to this advantage that of manifeſting very ſmall quantities of it. Diſtilled water impregnated with ſulphurated hydrogenous gas, or hepatic gas, extricated from ſolid alkaline ſulphurets (*livers of ſulphur*) by acids, preſented me with theſe properties. This ſolution blackens very deeply that of the aceto-tartrite of lead, and renders $\frac{1}{10000}$th of this ſalt in water or in wine very ſenſible. The ſenſibility of this reactive is ſuch, that we may dilute litharged wine with a ſufficient quantity of water to take away almoſt entirely the colour of the wine, and this reactive will ſtill produce a very manifeſt alteration. The ſulphurated water has, beſides the advantage not to occaſion any change in the wines which do not contain a metallic ſubſtance, and it is not precipitated by the acids of wine, like the ſolutions of alkaline ſulphurets. In order to procure this reactive pure, it is neceſſary to prepare it at the inſtant of the experiment, by receiving in a vial full of diſtilled water, and inverted upon a ſhelf of a ſmall hydro-pneumatic apparatus, filled with diſtilled water, the ſulphurated hydrogenous gas, ſeparated from the ſolid ſulphuret of potaſh by the ſulphuric or muriatic acid, and firſt filtered through water in another vial; when the ſecond vial contains the third of its volume of the ſulphurated hydrogenous gas, the gas is ſhaken ſtrongly with the water, which fills the two-thirds of the

the vial; and when the abſorption is over, the teſt liquor is prepared. This re-active changes very quickly in the air: it is neceſſary to make it the moment it is to be employed, and to keep it in a veſſel quite full and well corked. If there were any fear that the black colour and the precipitation by the gaſeous ſulphurated water ſhould not be ſufficient to prove the preſence of lead in ſpirituous liquors, I would obſerve, that this fear would be diminiſhed by employing the three re-actives mentioned in this memoir, and by depending only on the correſpondent effects of theſe three re-actives: but all ſuſpicion would be removed, by reducing the three precipitates by the blow-pipe, and obtaining globules of lead from each of them."

12
Method of detecting alum diſſolved in wine.

Some years ago, the Academy of Lyons propoſed the following prize-queſtion: What is the beſt method of aſcertaining the preſence and the quantity of *alum* diſſolved in wine, eſpecially in very deep coloured red wine? The prize was gained by M. J. S. Beraud. From his experiments, it appears that a mixture of lime-water and wine in any proportion whatever, will at the end of 12 or 15 hours furniſh a quantity of cryſtals, which may be ſeparated by filtration, and that theſe cryſtals will be eaſieſt diſcovered when the quantities of wine and lime-water are equal; but that wine containing alum diſſolved in it, will not form cryſtals when mixed with lime-water, but merely depoſits a muddy ſediment. To know therefore whether any wine contains alum or not, we have only to mix a ſmall quantity of it with lime-water: if cryſtals are formed, it contains no alum; if not, it does. Again, if wine contains alum, the reſiduum that remains after filtration will, as it dries, ſplit into quadrilateral ſegments, which will detach themſelves from the paper which contains them; but if the wine contains no alum, the reſiduum, after it is dry, will remain united and attached to the paper. If one meaſure of wine and two-thirds of a meaſure of lime-water depoſit cryſtals, we are certain that if the wine contains alum, the proportion of that alum to the wine will be leſs than 1 to 1152; if, when equal parts of wine and lime-water are mixed, no cryſtals be depoſited, we may be ſure that more than $\frac{1}{400}$th part of the maſs of wine conſiſts of alum.

A great proportion of the wine conſumed in this country is brought from Spain and Portugal; government has always diſcouraged the importation of French wines by heavy taxes. We are not ſure how far ſuch conduct is founded on good policy, as the French wines are confeſſedly the beſt, and might be the cheapeſt; but ſuch is the jealouſy and enmity that has always ſubſiſted between Britain and France, that both nations have been contented to injure themſelves, provided they could do a greater injury to their neighbours. Beſides, the advantages which Britain derives from the Portugal trade are very great, and it would not be eaſy perhaps to ſecure them on any other terms.

13
Directions for the treatment of imported wines.

It may be worth while to inſert here a few directions about the treatment of wines after they have been imported into this country.—On landing, the leſs they are expoſed the better; for they are affected by the ſeaſons, and more or leſs by climate. March and April are the proper times for ſhipping wines from France, and they will be landed in England and Ireland in the ſame degree of temperature. The great art in keeping wines is to prevent their fretting, which is done by keeping them in the ſame degree of heat. In ſpring and fall, the wines in Bourdeaux are ſubject to changes that may be dangerous, if not prevented by neceſſary rackings: theſe changes are ſolely the effects of the ſeaſons. If wines are chilled, and of courſe turn foul, from being ſhipped and landed in cold weather, they will ſoon recover by putting them in a warm vault, well covered with ſaw-duſt. As ſoon as they are in the vault, they ought to be covered up. But if ſhipped and landed in ſummer, if the ſmalleſt degree of fermentation be found on them, it will be requiſite to dip the bung cloths in brandy, and leave the bungs looſe for ſome days, to give it time to cool; and if in a fortnight or three weeks the fermentation do not ceaſe, and the wine become bright, it will be proper to rack it (matching the hogſheads well with brimſtone), and force it with the whites of eight eggs. If it then becomes fine, bung it tight, and let it remain ſo until it is bottled. If wines new landed are wanted ſoon for the bottle, it will be neceſſary to force them immediately, and let them remain bunged cloſe for at leaſt a month, to recover from the forcing, or if two months the better; for wines bottled in high order come much ſooner into drinking than if bottled when flat, which all wines are after forcing. Wine muſt never be bottled the leaſt foul, which produces a tendency to fret; and if bottled in this ſtate, will never come in order, but may poſſibly be loſt: for this there is no remedy but repeated rackings; and care muſt be taken (after rinſing the hogſheads well and drawing them) to burn a good piece of match in them. This cools the wine, and there is no danger of hurting the colour, for it recovers it in a little time: but if it did, it is abſolutely neceſſary; for if wine is ſuffered to continue on the fret, it will wear itſelf to nothing. Wines bottled in good order may be fit to drink in ſix months; but they are not in perfection before twelve: from that to two years they may continue ſo; but it would be improper to keep them longer, for wines in general have not the body they had formerly, from the vines being too much forced.

It ſometimes happens that wines ſcuddy and ſtubborn will not fall with one or even two forcings. It will then be proper to give them five or ſix gallons of good ſtrong wine, and force them with the whites of a dozen eggs, with a tea-ſpoonful of ſand produced from ſawing-marble, or a ſmall ſpoonful of fine ſalt. Bottled wine in winter ſhould be well covered with ſaw-duſt, and if the vaults are cold and damp, ſtrew it deep on the floor; if ſaw-duſt is thrown upon the hogſheads, and their ſides are bedded ſome inches thick, it will keep them from the fret.

The ſame treatment is to be regarded with white wines, except that they require to be higher matched, particularly Muſcat wines; ſuch as Frontignac, Beziers, &c. which being often ſweetened with honey, are very ſubject to fret; and theſe only frequent rackings, with a great deal of brimſtone, can cool. Hermitage, from not being ſufficiently dried, and poſſeſſing more richneſs than claret, is alſo very liable to come on the fret, and will require much the ſame treatment as the Muſcat wines. Attention ſhould be had to bottle in fine weather, when the wind is north; but to avoid cold or froſty weather. The months of April and October are favourable. The beſt time to bottle port wine is four years after the vintage, and to keep them two years in bottle before you begin to uſe them. When wines are racked, and the lees immediately paſſed through flannel bags into cloſe-necked jars, and directly bottled, there will be very little loſt by rackings, as the wine when fine may ſerve for filling up.

When wines are deſtined for warm climates, it may be proper to rinſe the hogſheads with brandy; and in bottling many rinſe the bottles and corks with it. Wines that have remained a certain time (three or four months) in a vault, and made leſs or more lee, ought never to be ſent into the country without firſt racking them, otherwiſe they may be liable to fret; and if bottled in that ſtate, may riſk being loſt.

Wines which may be ordered for immediate drinking will be forced on the ſhipping, and in a few weeks after they are landed will be fit for the bottle. The forcings proper for claret are the whites of a dozen eggs, beat up with a tea-ſpoonful of fine ſalt, and well worked with a forcing rod. Take care to uſe no bad egg. This is for one hogſhead.

The forcing for white wine is iſinglaſs diſſolved in wine. One ounce is ſufficient for two hogſheads. No ſalt is to be uſed in forcing the white wines. See *Croft on Wines*, 8vo, 1788.

14 Receipt for making raiſin-wine.

We ſhall inſert here the following receipt for making *raiſin wine*.—To a 20 gallon veſſel take 100 pounds of raiſins; pick off the ſtalks, chop them groſsly, and put them into an open tub more wide than deep. Add two parts in three of the water to them, and let them ſtand 15 days, ſtirring them well every day. Then ſtrain and preſs them, putting aſide the liquor that runs from them. Add the remainder of the water to the raiſins that have thus been preſſed, and let it ſtand upon them one week, frequently ſtirring them as before. Then preſs off the liquor, and add it to what you firſt collected; putting both runnings together into your veſſel, together with one quart of brandy. To colour it, burn three-fourths of a pound of ſugar into a ſmall quantity of the liquor, and add this to the wine. When the liquor in the barrel has done ſinging, ſtop the veſſel cloſe, and let it ſtand till fit to be bottled. The greater the quantity which the veſſel holds, and the longer it is kept in the wood, the better will it be.

As ſome of the hints for making wines in Champagne may be uſeful in the manufacture of the wines of this country, we inſert the following abridged account of the different proceſſes that are followed in making white and red champagne.

Great care is neceſſary for making white wine. The ripeſt bunches muſt be carefully gathered, freed from rotten, dry, and bruiſed grapes, put into large baſkets covered with a cloth to keep them from the ſun, carried to the ſhade, and kept there till the evening, when they are to be ſpeedily preſſed. The grapes being laid on the bed of the preſs, they are covered with three or four layers of flat ſtones, and the preſs turned. The juice having run for four or five minutes, the preſs is turned backward, the ſtones removed, the grapes which have protruded thruſt into the heap, the ſtones replaced, and the preſs turned again. The juice from three of ſuch preſſures, which will not require an hour, is put by itſelf for the beſt wine into a vat, where it is left all night to ſettle.

The next morning this juice is poured off from the ſediment, and put into new well rinſed caſks. In theſe it ferments violently at firſt, but afterwards imperceptibly, till about the end of December it becomes fine, having gone through all the ſtages of depuration. It is then racked off in dry weather, on a clear froſty day, and fined with iſinglaſs. About a pound is ſufficient for 40 puncheons. The iſinglaſs being diſſolved is well beaten, diluted with wine taken from the caſk, then poured into it, and the whole well ſtirred by an inſtrument introduced at the bung-hole. The wine thus left to ſettle ferments ſlightly again, till it be ſtopped by the cold weather, or by time. In a month or ſix weeks it is racked off again, and has another fining with half the quantity of iſinglaſs.

For making red wine, the grapes are gathered with the ſame precautions as for making white, taking only the black grapes. Theſe are bruiſed in particular veſſels, by men treading on them with ſtrong wooden ſhoes: part of the ſtalks are thrown away, and the *muſt* is left in covered veſſels to ferment ſufficiently to extract the colouring matter from the pellicles. In ſome years, three or four days are ſufficient; in others it requires 10, 15, or even 20. When the fermentation begins, the huſks and ſtalks are forced down ſo as to be covered with the muſt, either by means of ſtrong poles furniſhed with croſs pegs, or, which is better, by a couple of ſtrong men going into the vat, and well treading and mixing its contents. When the air above the vat extinguiſhes a candle, the ſtalks and huſks riſe forcibly, whatever pains be taken frequently to ſink them, that the muſt may not acquire a diſagreeable taſte; the contents of the vat experience a degree of ebullition, and the colouring matter is decompoſed. The fermentation muſt be made to ſtop here, that the wine may not acquire a hard taſte, which even time cannot deſtroy.

About the end of December, when the fermentation has ceaſed, the wine is racked off from the lees; about the middle of May it is racked off again; the barrels are freſh hooped, and the wine is put into the cellar. When it is to be ſent to the conſumer, it is racked a third time; the whites of five or ſix freſh eggs are well beaten up in a pint of water, for every puncheon holding 240 bottles. Good red champagne will keep in bottles from ſix to twelve years.

WINE-Preſs, a machine contrived to ſqueeze the juice out of grapes, and conſiſting of ſeveral pieces of timber, variouſly diſpoſed, which compoſe three bodies of timber-work, cloſely united to the axis, which ſerves as a ſwing whereby it may be moved by the vice. Of theſe there are different ſizes as well as different conſtructions; for an account of which, illuſtrated by figures, ſee Miller's Gardener's Dictionary, article *WINE-Preſs*.

Spirit of WINE, or *Alcohol*, a name given by chemiſts to every ardent ſpirit produced by diſtillation. See *CHEMISTRY Index*.

WING, that part of a bird, inſect, &c. whereby it is enabled to fly. See BIRD and ORNITHOLOGY.

WINGS, in military affairs, are the two flanks or extremes of an army, ranged in form of a battle; being the right and left ſides thereof.

WINTER, one of the four ſeaſons or quarters of the year. See SEASON, &c.

Winter commences on the day when the ſun's diſtance from the zenith of the place is greateſt, and ends on the day

day when its diſtance is at a mean between the greateſt and leaſt.

Under the equator, the winter as well as other ſeaſons returns twice every year; but all other places have only one winter in the year: which in the northern hemiſphere begins when the ſun is in the tropic of Capricorn, and in the ſouthern hemiſphere when in the tropic of Cancer; ſo that all places in the ſame hemiſphere have their winter at the ſame time.

WINTER-Berry. See PHYSALIS, BOTANY *Index.*

WINTERA, a genus of plants of the claſs of polyandria, and in the natural ſyſtem arranged under the 12th order, *Holoraceæ.* See BOTANY and MATERIA MEDICA *Index.*

WINTON, ANDREW, a Scottiſh poet and hiſtorian of the 14th century; but very little is known of his life. He was a canon regular of St Andrews, and was prior of the monaſtery of St Serf in the iſland of Loch Leven in Kinroſs-ſhire; for in the chartulary of the priory of St Andrews there are ſeveral public inſtruments of Andrew Winton, as prior of Loch Leven. They are dated between the years 1395 and 1413, ſo that Winton muſt have been cotemporary with Barbour, whoſe merits are on ſeveral occaſions celebrated by him. Winton is beſt known as the author of the *Orygynale Cronykill of Scotland.* This work was undertaken at the requeſt of Sir John Wemyſs, the anceſtor of the noble family of that name. It remained neglected for ſeveral centuries, but in 1795 a ſplendid edition of that part of it relative to Scottiſh affairs, was publiſhed by Mr Macpherſon. The time of Winton's death is unknown; but, as he mentions the death of Robert duke of Albany, which happened in 1420, the hiſtorian muſt have been alive at that time.

WIRE, a piece of metal drawn through the hole of an iron into a thread of a fineneſs anſwerable to the hole it paſſed through.

Wires are frequently drawn ſo fine as to be wrought along with other threads of ſilk, wool, flax, &c.

The metals moſt commonly drawn into wire are gold, ſilver, copper, and iron. Gold-wire is made of cylindrical ingots of ſilver, covered over with a ſkin of gold, and thus drawn ſucceſſively through a vaſt number of holes, each ſmaller and ſmaller, till at laſt it is brought to a fineneſs exceeding that of a hair. That admirable ductility which makes one of the diſtinguiſhing characters of gold, is nowhere more conſpicuous than in this gilt wire. A cylinder of 48 ounces of ſilver, covered with a coat of gold, only weighing one ounce, as Dr Halley informs us, is uſually drawn into a wire, two yards of which weigh no more than one grain; whence 98 yards of the wire weigh no more than 49 grains, and one ſingle grain of gold covers the 98 yards; ſo that the ten-thouſandth part of a grain is above one-eighth of an inch long.

In 1784, Mr Roſwag of Straſbourg preſented to the board of trade ſome gauze made of iron wire, for which he received a reward; and the loom he invented for making it was lodged in the collection of machines at Vaucanſon. In 1799 Mr Rochon made others, and coated them with a tranſparent glue, to be ſubſtituted inſtead of horn for ſhip lanterns, to be uſed between decks, and in engagements by night. He has ſince conceived, that with a thin coating of plaſter they might be employed to preſerve ſhips from fire, and buildings on ſhore ſtill more eaſily; or at leaſt that they might render the ravages of fire leſs frequent, and leſs terrible. Theſe gauzes might be very uſeful too for theatrical decorations, which would not be liable to take fire. Their only inconvenience is their being ſo little flexible; but Mr Rochon does not deſpair of means being found by chemiſtry to remedy this imperfection, and it was with a view of calling attention to this ſubject, that he read a paper on it to the claſs.

WIRE of Lapland. The inhabitants of Lapland have a ſort of ſhining ſlender ſubſtance in uſe among them on ſeveral occaſions, which is much of the thickneſs and appearance of our ſilver wire, and is therefore called, by thoſe who do not examine its ſtructure or ſubſtance, *Lapland wire.* It is made of the ſinews of the rein deer, which being carefully ſeparated in the eating, are, by the women, after ſoaking in water and beating, ſpun into a ſort of thread, of admirable fineneſs and ſtrength, when wrought to the ſmalleſt filaments; but when larger, is very ſtrong, and fit for the purpoſes of ſtrength and force. Their wire, as it is called, is made of the fineſt of theſe threads covered with tin. The women do this buſineſs; and the way they take is to melt a piece of tin, and placing at the edge of it a horn, with a hole through it, they draw theſe ſinewy threads, covered with the tin, through the hole, which prevents their coming out too thick covered. This drawing is performed with their teeth; and there is a ſmall piece of bone placed at the top of the hole, where the wire is made flat; ſo that we always find it rounded on all ſides but one, where it is flat.

This wire they uſe in embroidering their clothes, as we do gold and ſilver; they often ſell it to ſtrangers, under the notion of its having certain magical virtues.

WISDOM, uſually denotes a higher and more refined notion of things immediately preſented to the mind, as it were, by intuition, without the aſſiſtance of ratiocination.

Sometimes the word is more immediately uſed, in a moral ſenſe, for what we call *prudence*, or *diſcretion*, which conſiſts in the ſoundneſs of the judgement, and a conduct anſwerable thereto.

WISDOM of Solomon, one of the books of the Apocrypha. It abounds with Platonic language, and was probably written after the Cabaliſtic philoſophy was introduced among the Jews.

WIT, is a quality of certain thoughts and expreſſions, much eaſier perceived than defined. According to Mr Locke, wit lies in the aſſemblage of ideas, and putting thoſe together with quickneſs and variety, wherein can be found any reſemblance or congruity, thereby to make up pleaſant pictures and agreeable viſions to the fancy. Mr Addiſon limited this definition conſiderably, by obſerving, that every reſemblance of ideas does not conſtitute wit, but thoſe only which produce delight and ſurpriſe. Mr Pope defined wit to be a quick conception and an eaſy delivery: while, according to a late writer, it conſiſts in an aſſimilation of diſtant ideas.

The word *wit* originally ſignified *wiſdom.* A *witte* was anciently a *wiſe man:* the *wittenagemot*, or Saxon parliament, an aſſemblage of wiſe men. So late as the reign of Elizabeth, a man of pregnant *wit*, of great *wit*, was a man of vaſt *judgement*. We ſtill ſay, *in his wits*, *out of his wits*, for in or out of ſound mind. The word, however, is now applied in a more limited ſenſe.

Without attempting to expoſe the inaccuracy of the definitions above mentioned, or hazarding a definition of our own where ſo many eminent men have failed, we ſhall endeavour to ſhow in what true wit conſiſts.

It is evident that wit excites in the mind an agreeable ſurpriſe, and that this is owing entirely to the ſtrange aſſemblage of related ideas preſented to the mind. This end is effected, 1. By debaſing things pompous or *ſeemingly* grave; 2. By aggrandizing things little or frivolous; 3. By ſetting ordinary objects in a particular and uncommon point of view, by means not only remote but apparently contrary. Of ſo much conſequence are ſurpriſe and novelty, that, nothing is more taſteleſs, and ſometimes diſguſting, than a joke that has become ſtale by frequent repetition. For the ſame reaſon, even a pun or happy alluſion will appear excellent when thrown out extempore in converſation, which would be deemed execrable in print. In like manner, a witty repartee is infinitely more pleaſing than a witty attack: for though, in both caſes, the thing may be equally new to the reader or hearer, the effect on him is greatly injured, when there is acceſs to ſuppoſe that it may be the ſlow production of ſtudy and premeditation. This, however, holds moſt with regard to the inferior tribes of witticiſms, of which their readineſs is the beſt recommendation.

Campbell's Philoſophy of Rhetoric, vol. i.

We ſhall illuſtrate theſe obſervations by ſubjoining a ſpecimen or two of each of theſe ſorts of wit:

Of the firſt ſort, which conſiſts in the debaſement of things great and eminent, Butler, amongſt a thouſand other inſtances, hath given us thoſe which follow:

> And now had Phœbus in the lap
> Of Thetis taken out his nap:
> And, like a lobſter boil'd, the morn
> From black to red began to turn.
> *Hudibras*, part ii. canto 2.

Here the low allegorical ſtyle of the firſt couplet, and the ſimile uſed in the ſecond, afford us a juſt notion of this loweſt ſpecies, which is diſtinguiſhed by the name of the *ludicrous*. Another ſpecimen from the ſame author you have in theſe lines:

> Great on the bench, great in the ſaddle,
> That could as well bind o'er as ſwaddle,
> Mighty he was at both of theſe,
> And ſtyl'd of *war*, as well as *peace*:
> So ſome rats of amphibious nature,
> Are either for the *land* or *water*.
> *Ibid.* part i. canto 1.

In this coarſe kind of drollery, thoſe laughable tranſlations or paraphraſes of heroic and other ſerious poems, wherein the authors are ſaid to be traveſtied, chiefly abound.

The ſecond kind, conſiſting in the aggrandiſement of little things, which is by far the moſt ſplendid, and diſplays a ſoaring imagination, theſe lines of Pope will ſerve to illuſtrate:

> As Berecynthia, while her offspring vie
> In homage to the mother of the ſky,
> Surveys around her in the bleſt abode,
> An hundred ſons, and every ſon a god:
> Not with leſs glory mighty Dulneſs crown'd,
> Shall take thro' Grubſtreet her triumphant round;
> And her Parnaſſus glancing o'er at once,
> Behold a hundred ſons, and each a dunce.

This whole ſimilitude is ſpirited. The parent of the celeſtials is contraſted by the daughter of night and chaos; heaven by Grubſtreet; gods by dunces. Beſides, the parody it contains on a beautiful paſſage in Virgil adds a particular luſtre to it. This ſpecies we may term the *thraſonical*, or *the mock-majeſtic*. It affects the moſt pompous language, and ſonorous phraſeology, as much as the other affects the reverſe, the vileſt and moſt grovelling dialect.

To this claſs alſo we muſt refer the application of grave reflections to mere trifles. For that *great* and *ſerious* are naturally aſſociated by the mind, and likewiſe little and trifling, is ſufficiently evinced by the common modes of expreſſion on theſe ſubjects uſed in every tongue. An appoſite inſtance of ſuch an application we have from Philips:

> My galligaſkins, that have long withſtood
> The winter's fury and encroaching froſts,
> By time ſubdued, (*What will not time ſubdue!*)
> An horrid chaſm diſcloſe. *Splendid Shilling.*

Of the third ſpecies of wit, which is by far the moſt multifarious, and which reſults from what may be called the queerneſs or ſingularity of the imagery, we ſhall give a few ſpecimens that will ſerve to mark ſome of its principal varieties. To illuſtrate all would be impoſſible. The firſt ſhall be where there is an apparent contrariety in the things ſhe exhibits as connected. This kind of contraſt we have in theſe lines of Garth:

> Then Hydrops next appears amongſt the throng;
> Bloated and big ſhe ſlowly ſails along:
> But like a miſer in exceſs ſhe's poor,
> And pines for thirſt amidſt her watery ſtore.
> *Diſpenſary.*

A ſecond ſort is, where the things compared are what with dialecticians would come under the denomination of *diſparates*, being ſuch as can be ranked under no common genus. Of this we ſhall ſubjoin an example from Young:

> Health chiefly keeps an Atheiſt in the dark;
> A fever argues better than a *Clarke*:
> Let but the logic in his pulſe decay,
> The Grecian he'll renounce, and learn to pray.
> *Univerſal Paſſion.*

A third variety in this ſpecies ſprings from confounding artfully the proper and the metaphorical ſenſe of an expreſſion. In this way, one will aſſign as a motive what is diſcovered to be perfectly abſurd, when but ever ſo little attended to; and yet from the ordinary meaning of the words, hath a ſpecious appearance on a ſingle glance. Of this kind we have an inſtance in the ſubſequent lines:

> While thus the lady talk'd, the knight
> Turn'd th' outſide of his eyes to white,

As men of inward light are wont
To turn their optics in upon't.
Hudibras, part iii. canto 1.

For whither can they turn their eyes more properly than to the light?

A fourth variety, much reſembling the former, is when the argument or compariſon (for all argument is a kind of compariſon) is founded on the ſuppoſal of corporeal or perſonal attributes in what is ſtrictly not ſuſceptible of them; as in this,

But Hudibras gave him a twitch
As quick as lightning in the breech,
Juſt in the place where honour's lodg'd,
As wiſe philoſophers have judg'd:
Becauſe a kick in that place more
Hurts honour than deep wounds before.
Ibid. part ii. canto 3.

The fifth, and only other variety which we ſhall mention, is that which ariſes from a relation, not in the things ſignified, but in the ſigns of all relations, no doubt the ſlighteſt. Identity here gives riſe to puns and clinches; reſemblance to quibbles, cranks, and rhimes: Of theſe it is quite unneceſſary to exhibit ſpecimens.

Wit, *John de*, a celebrated penſioner of Holland, and one of the greateſt politicians of his time, was the ſon of Jacob de Wit, burgomaſter of Dort, and was born in 1625. He became well ſkilled in civil law, politics, mathematics, and other ſciences; and wrote a treatiſe on the Elements of Curved lines, publiſhed by Francis Schooten. Having taken his degree of doctor of law, he travelled into foreign courts, where he became eſteemed for his genius and prudence. At his return to his native country in 1650, he became penſionary of Dort, then counſellor-penſionary of Holland and Weſt Frieſland, intendant and regiſter of the fiefs, and keeper of the great ſeal. He was thus at the head of affairs in Holland; but his oppoſition to the reeſtabliſhment of the office of ſtadtholder, which he thought a violation of the freedom and independence of the republic, coſt him his life, when the prince of Orange's party prevailed. He and his brother Cornelius were aſſaſſinated by the populace at the Hague in 1674, aged 47.

WITCH, a perſon guilty of witchcraft.

WITCHCRAFT, a ſupernatural power which perſons were formerly ſuppoſed to obtain the poſſeſſion of by entering into a compact with the devil. They gave themſelves up to him body and ſoul; and he engaged, that they ſhould want for nothing, and that he would avenge them upon all their enemies. As ſoon as the bargain was concluded, the devil delivered to the witch an imp, or familiar ſpirit, to be ready at a call, and do whatever it was directed. By the aſſiſtance of this imp and the devil together, the witch, who was almoſt always an old woman, was enabled to tranſport herſelf in the air on a broomſtick or a ſpit to diſtant places to attend the meetings of the witches. At theſe meetings the devil always preſided. They were enabled alſo to transform themſelves into various ſhapes, particularly to aſſume the forms of cats and hares, in which they moſt delighted; to inflict diſeaſes on whomſoever they thought proper; and to puniſh their enemies in a variety of ways.

The belief that certain perſons were endowed with ſupernatural power, and that they were aſſiſted by inviſible ſpirits, is very ancient. The *ſagæ* of the Romans ſeem rather to have been ſorcerers than witches; indeed the idea of a witch, as above deſcribed, could not have been prevalent till after the propagation of Chriſtianity, as the heathens had no knowledge of the Chriſtian *devil*.

Witchcraft was univerſally believed in Europe till the 16th century, and even maintained its ground with tolerable firmneſs till the middle of the 17th. Vaſt numbers of reputed witches were convicted and condemned to be burnt every year. The methods of diſcovering them were various. One was, to weigh the ſuppoſed criminal againſt the church bible, which, if ſhe was guilty, would preponderate: another, by making her attempt to ſay the Lord's Prayer; this no witch was able to repeat entirely, but would omit ſome part or ſentence thereof. It is remarkable, that all witches did not heſitate at the ſame place; ſome leaving out one part, and ſome another. Teats, through which the imps ſucked, were indubitable marks of a witch: theſe were always raw, and alſo inſenſible; and, if ſqueezed, ſometimes yielded a drop of blood. A witch could not weep more than three tears, and that only out of the left eye. This want of tears was, by the witch-finders, and even by ſome judges, conſidered as a very ſubſtantial proof of guilt. Swimming a witch was another kind of popular ordeal generally practiſed: for this ſhe was ſtripped naked, and croſs-bound, the right thumb to the left toe, and the left thumb to the right toe. Thus prepared, ſhe was thrown into a pond or river, in which, if guilty, ſhe could not ſink; for having, by her compact with the devil, renounced the benefit of the water of baptiſm, that element, in its turn, renounced her, and refuſed to receive her into its boſom. Sir Robert Filmer mentions two others by fire: the firſt, by burning the thatch of the houſe of the ſuſpected witch; the other, burning any animal ſuppoſed to be bewitched by her, as a hog or ox. Theſe, it was held, would force a witch to confeſs.

Provincial Gloſſary.

The trial by the ſtool was another method uſed for the diſcovery of witches. It was thus managed: Having taken the ſuſpected witch, ſhe was placed in the middle of a room upon a ſtool or table, croſs-legged, or in ſome other uneaſy poſture; to which if ſhe ſubmitted not, ſhe was then bound with cords: there ſhe was watched, and kept without meat or ſleep for the ſpace of 24 hours (for, they ſaid, within that time they ſhould ſee her imp come and ſuck). A little hole was likewiſe made in the door for imps to come in at; and leſt it ſhould come in ſome leſs diſcernible ſhape, they that watched were taught to be ever and anon ſweeping the room, and, if they ſaw any ſpiders or flies, to kill them: if they could not kill them, then they might be ſure they were imps. If witches, under examination or torture, would not confeſs, all their apparel was changed, and every hair of their body ſhaven off with a ſharp razor, leſt they ſhould ſecrete magical charms to prevent their confeſſing. Witches were moſt apt to confeſs on Fridays.

By ſuch trials as theſe, and by the accuſation of children,

dren, old women, and fools, were thouſands of unhappy women condemned for witchcraft, and burnt at the ſtake. In the 18th volume of the Statiſtical Account of Scotland there is the trial of two witches, William Coke and Aliſon Dick, in Kirkaldy, in 1636. The evidence on which they were condemned is abſolutely ridiculous: they were, however, burnt for witchcraft. The expences which the town and kirk-ſeſſion were put to on this occaſion were as follows:

In primis.—To Mr James Miller, when he went to Preſtowne for a man to try them, 47s. - -	L.2	7
Item.—To the man of Culroſs, (the executioner), when he went away the firſt time, 12s. - -	0	12
Item.—For coals for the witches, 24s.	1	4
Item.—In purchaſing the commiſſion,	9	3
Item.—For one to go to Finmouth for the laird to ſit upon their aſſize as judge, - - -	0	6
Item.—For harden to be jumps to them,	3	10
Item.—For making of them, -	0	8
Summa for the kirk's part	L. 17	10 Scots.

The Town's part of expences deburſed extraordinarily upon William Coke and Aliſon Dick.

In primis.—For 10 loads of coals to burn them, 5 merks, -	L. 3	6	8
Item.—For a tar barrel, 14s. -	0	14	0
Item.—For towes, - -	0	6	0
Item.—To him that brought the executioner, - -	2	18	0
Item.—To the executioner for his pains, - - -	8	14	0
Item.—For his expences here,	0	16	4
Item.—For one to go to Finmouth for the laird - -	0	6	0
Summa town part,	L. 17	1	0 Scots.
Both,	L. 34	11	0
Or	L. 2	17	7 Ster.

Dr Ferriar, Mancheſter Tranſ. vol. iii.

For a conſiderable time after the inquiſition was erected, the trials of witches (as heretics) were confined to that tribunal; but the goods of thoſe who were condemned being confiſcated to the holy office, its miniſters were ſo active in diſcovering ſorcerers, that the different governments found it neceſſary to deprive them of the cogniſance of this crime. On the continent, commiſſioners were then appointed for the diſcovery and conviction of witches, who, though leſs active than the inquiſitors, were but too zealous in proſecuting their function. In 1494, Sprenger and Inſtitor, two perſons employed in this commiſſion, publiſhed a collection of trials, moſt of which had come before themſelves, under the title of *Malleus Maleficarum:* this ſerved as a kind of inſtitute for their ſucceſſors.

The firſt writers againſt witchcraft were ſtigmatized as Atheiſts, though they only endeavoured to prove the imbecility of the perſons accuſed, and the infatuation or the knavery of their accuſers. Such were the epithets beſtowed by Dr Henry More, and even by Cudworth himſelf. Wierus, the diſciple of the celebrated Agrippa, gave riſe to the firſt great controverſy on this ſubject. His maſter had taught him humanity; and he endeavoured, but with too feeble a hand, to ſtop the bloody proceedings of the judges. Wierus appears to have been a well-diſpoſed, weak man, with extenſive reading on his ſubject, but too narrow-minded to comprehend it thoroughly. He involved himſelf in unſpeakable difficulties, by admitting the action of ſupernatural powers in certain diſeaſes, and in poſſeſſions, while he denied that witches had any concurrence in them. Theſe appearances (ſaid he) are illuſions of the devil, who perſuades ſimple and melancholy perſons that the miſchief he himſelf performs, is done by them, and at their pleaſure. He was weak enough to attempt the explanation of every ſtory alleged by his antagoniſts, without queſtioning the truth of the facts.

Bodinus, a French lawyer of eminence, who had aſſiſted at ſeveral trials of witches, wrote againſt Wierus, in his *Demonomania.* He urged the concurrent teſtimonies of ſufficient witneſſes, and the confeſſions of the witches themſelves, to eſtabliſh the exiſtence of ſorcery. Wierus owned that the unhappy perſons believed themſelves to be guilty of the crimes alleged againſt them, but that they were deceived by the devil. But what do you make of the witches meetings, cried Bodinus? The witches (replied his antagoniſt) are atrabilious. This explanation was ſo unſatisfactory that Wierus paſſed for a magician, whom the devil had furniſhed with ſpecious arguments to ſave others from puniſhment. Lerchemer, Godelmann, Ewichius, Ewaldus, and ſome others, followed him, notwithſtanding this ſtigma; but they were oppoſed by men of more acuteneſs and conſiſtency than themſelves; by Remigius, who had condemned ſeveral hundreds of ſorcerers to the flames; Deltio, whoſe book is a complete Corpus Magiæ; Cujas, Eraſtus, Scribonius, Camerarius, and a crowd of others.

In this country, while the belief in withcraft was ſupported by royal authority (for James I. is univerſally known to have written on demonology) countenanced by Bacon, and generally adopted among the people, only one writer was hardy enough to oppoſe it. This was Reginald Scott, who publiſhed a collection of impoſtures detected, under the title of Diſcoveries of Witchcraft. James ordered the book to be burnt by the common executioner, and the judges continued to burn witches as uſual. During the civil wars, upwards of eighty were hanged in Suffolk, on the accuſations of Hopkins the witch-finder. Webſter was the next writer againſt witchcraft; but he had a different fate from that of Scott, for moſt of his arguments were refuted by Glanville. This very acute writer was induced to publiſh his Philoſophical Conſiderations about Witchcraft, by the apprehenſion, that the increaſing diſbelief of witches and apparitions tended to affect the evidences of religion, and even of a Deity. In reſpect of argument, he was certainly ſuperior to his adverſaries; his reaſoning is perſpicuous, though ſometimes ſubtle, reſted on the moſt ſpecious foundations of evidence, and arranged with great ſkill.

On the continent, this controverſy ſeemed almoſt forgotten, till Bekker publiſhed his *Monde Enchantée,* in which he denied the exiſtence of witches on the Carteſian principle, that the Deity is the ſource of all action, conſequently actions ſo oppoſite to his nature and attributes cannot be ſuppoſed to exiſt. He was anſwered by

Frederick

Frederick Hoffman, the father of the modern theory and practice of medicine, in his diſſertation *De Diaboli Potentia in Corpora*.

The lateſt witchcraft frenzy was in New England, about 1692, when the execution of witches became a calamity more dreadful than the ſword or the peſtilence. The accuſers became ſo daring, that neither civil nor religious authority would have proved a ſecurity againſt their attacks, if all the proſecutions had not been ſuddenly dropped, and the priſoners ſet at liberty. So far did thoſe wretches proceed in abſurdity, that a dog was accuſed of throwing perſons into fits by looking at them. As ſoon as the proſecutions were ſtopped, all reports of witchcraft ceaſed.

It would be ridiculous to attempt a ſerious refutation of the exiſtence of witches; and at preſent, luckily, the taſk is unneceſſary. In this country, at leaſt, the diſcouragement long given to all ſuſpicion of witchcraft, and the repeal of the ſtatutes againſt that crime, have very much weakened, though perhaps they have not entirely eradicated, the perſuaſion. On the continent, too, it is evidently on the decline; and notwithſtanding the exertions of Dr De Haen, and of the celebrated Lavater, we have little doubt but that in a ſhort time poſterity will wonder at the credulity of their anceſtors. That there ever were witches, is an opinion that cannot for a moment be believed by a thinking man. The actions imputed to them were either abſurd or impoſſible; the witneſſes by whoſe evidence they were condemned, either weak enthuſiaſts or downright villains: and the confeſſions aſcribed to the witches themſelves, effects of a diſordered imagination produced by cruel treatment and exceſſive watchings. As to the nightly meetings, demonologiſts themſelves have been obliged to confeſs, that they were nothing elſe but uneaſy dreams, often produced by ſoporific compoſitions. The facts which have been brought forward by the advocates for witchcraft bear in their front the moſt evident marks of trick and impoſture; and this has conſtantly been found out whenever theſe facts have been properly examined. See SORCERY.

WITENA MOT, or WITENA *Gemot*, among the Anglo-Saxons, was term which literally ſignified the aſſembly of the wiſe men; and was applied to the great council of the nation, of latter days called the *parliament*.

WITHERS *of a* HORSE, the juncture of the ſhoulder-bones at the bottom of the neck and mane, towards the upper part of the ſhoulder.

WITNESS, in *Law*, a perſon who gives evidence in any cauſe, and is ſworn to ſpeak the truth, the whole truth, and nothing but the truth.

Trial by WITNESSES, a ſpecies of trial without the intervention of a jury. This is the only method of trial known to the civil law, in which the judge is left to form in his own breaſt his ſentence upon the credit of the witneſſes examined: but it is very rarely uſed in the Engliſh law, which prefers the trial by jury before it in almoſt every inſtance. Save only that when a widow brings a writ of dower, and the tenant pleads that the huſband is not dead; this being looked upon as a dilatory plea, is in favour of the widow, and for greater expedition allowed to be tried by witneſſes examined before the judges: and ſo, ſaith Finch, ſhall no other caſe in our law. But Sir Edward Coke mentions ſome others; as, to try whether the tenant in a real action was duly ſummoned, or the validity of a challenge to a juror: ſo that Finch's obſervation muſt be confined to the trial of direct and not collateral iſſues. And in every caſe Sir Edward Coke lays it down, that the affirmative muſt be proved by two witneſſes at the leaſt.

WITTENBERG, a city of Germany, capital of the circle of Upper Saxony, 50 miles north of Dreſden. It is under immediate vaſſalage, and the ſeat of an aulic judicatory, a general ſuperintendency, an inſpection and conſiſtory. The town is not large; but is well fortified, and contains a famous univerſity, in which Melancthon was a profeſſor. In this place Martin Luther firſt began to preach againſt the pope's indulgences; and in the cathedral of All Saints he is ſaid to have been buried. In the old citadel of this town the ancient Saxon electors uſed to reſide. Beſides the univerſity, there is a Latin ſchool in the town, with ſix maſters. The library belonging to the univerſity is ſaid to be very valuable. In 1756 the Pruſſians being maſters of the town, deſtroyed a part of its fortifications. E. Long. 12. 47. N. Lat. 51. 49.

WOAD. See ISATIS, BOTANY *Index*; ſee alſo DYEING.

The preparation of woad for dyeing, as practiſed in France, is minutely deſcribed by Aſtruc, in his Memoirs for a Natural Hiſtory of Languedoc. The plant puts forth at firſt five or ſix upright leaves, about a foot long and ſix inches broad: when theſe hang downwards, and turn yellow, they are fit for gathering: five crops are gathered in one year. The leaves are carried directly to a mill, much reſembling the oil or tan mills, and ground into a ſmooth paſte. If this proceſs was deferred for ſome time, they would putrefy, and ſend forth an inſupportable ſtench. The paſte is laid in heaps, preſſed cloſe and ſmooth, and the blackiſh cruſt, which forms on the outſide, reunited if it happens to crack: if this was neglected, little worms would be produced in the cracks, and the woad would loſe a part of its ſtrength. After lying for fifteen days, the heaps are opened, the cruſt rubbed and mixed with the inſide, and the matter formed into oval balls, which are preſſed cloſe and ſolid in wooden moulds. Theſe are dried upon hurdles: in the ſun, they turn black on the outſide; in a cloſe place, yellowiſh, eſpecially if the weather be rainy. The dealers in this commodity prefer the firſt, though it is ſaid the workmen find no conſiderable difference betwixt the two. The good balls are diſtinguiſhed by their being weighty, of an agreeable ſmell, and when rubbed, of a violet colour within. For the uſe of the dyer, theſe balls require a farther preparation: they are beat with wooden mallets, on a brick or ſtone floor, into a groſs powder; which is heaped up in the middle of the room to the height of four feet, a ſpace being left for paſſing round the ſides. The powder, moiſtened with water, ferments, grows hot, and throws out a thick fetid fume. It is ſhovelled backwards and forwards, and moiſtened every day for twelve days; after which it is ſtirred leſs frequently, without watering, and at length made into a heap for the dyer.

WOAHOO, one of the Sandwich iſlands, lying to the north-weſt of Morotoi, at the diſtance of ſeven leagues. From the appearance of the north-eaſt and north-weſt parts, it is the fineſt iſland of the group. Nothing can exceed the verdure of the hills, the variety of wood and lawn, and rich cultivated valleys, which the whole face of the country diſplays. A bay is formed by the north and weſt extremities, into which a fine river empties itſelf, through a deep valley; but as the water is brackiſh for 200 yards from the entrance, watering in it is not convenient. It contains about 60,000 inhabitants. Lieutenant Hergeſt, commander of the Dædalus ſtore-ſhip, who had been ſent from England, in 1791, to New South Wales, and thence to the Southern Pacific ocean, with a ſupply of proviſions for the Diſcovery ſloop, Captain Vancouver, then on a voyage of diſcovery, was here ſurpriſed and murdered by the natives, together with Mr Gooch, the aſtronomer. W. Long. 157. 51. N. Lat. 21. 43.

WODEN. See ODIN, and MYTHOLOGY, N° 40.

WODEVILLE, ANTHONY, earl of Rivers, brother to the queen of Edward IV. was born in the end of 1442, or in the beginning of 1443. Though one of the moſt accompliſhed men of his age, very little is known of his private hiſtory. He was early and conſtantly employed either in the tumults of thoſe turbulent times, or in diſcharging the duties of ſome of the higheſt offices of the ſtate, with which he was inveſted. Yet he found leiſure to cultivate letters, and to be the author of works which, though of little value now, made ſome noiſe in that age, when learning was at a low ebb in England. Theſe conſiſted chiefly of tranſlations from the French; and his lordſhip and his printer Caxton, were the firſt Engliſh writers who had the pleaſure to ſee their works publiſhed from the preſs. This accompliſhed, brave, and amiable nobleman was treacherouſly impriſoned by Richard III. in Pomfret caſtle, where, during his confinement, he compoſed a ſhort poem, which has been preſerved by John Rous of Warwick, and breathes, ſays Dr Henry, a noble ſpirit of pious reſignation to his approaching fate. He was beheaded on the 23d of June 1483, in the 41ſt year of his age.

WODROW, ROBERT, a clergyman of the weſt of Scotland who lived in the beginning of the 18th century; well known as the author of an Eccleſiaſtical Hiſtory of that kingdom during the latter part of the preceding century. His father, Mr James Wodrow, was a man of learning and piety. He preached occaſionally to the perſecuted Preſbyterians, and taught a little academy of their ſtudents of philoſophy and theology at Glaſgow, before the Revolution. About that time he was ordained one of the miniſters of that city, continuing his connexion with the academy till he was elected profeſſor of theology by the univerſity in the year 1692. He taught with reputation and ſucceſs till his death in 1708.

His ſon Robert was born in the year 1679; his mother being then in the 51ſt year of her age. Her death (though it did not happen till ſeveral years after), was then fully expected; and his father, obnoxious to a tyrannical government, narrowly eſcaped impriſonment, or ſomething worſe, by attempting to obtain a laſt ſhort interview with her. As he paſſed the town guard-houſe, he was marked, and ſoon followed by the ſoldiers into his own houſe, and even into his wife's bed-chamber, where he was concealed. Their officer checked this violence; ſent them out of the room, and left the houſe himſelf; placing, however, centinels both within and without, till the birth ſhould be over. In half an hour after, Mr Wodrow at his wife's ſuggeſtion, aſſumed the bonnet and great-coat of the ſervant of the phyſician then in attendance; and carrying the lantern before him, made an eaſy eſcape through the midſt of the guards. They ſoon renewed their ſearch with marks of irritation, thruſting their ſwords into the very bed where the lady lay; who pleaſantly deſired them to deſiſt, "for the bird (ſaid ſhe) is now flown."

His ſon Robert went through the uſual courſe of literary education at Glaſgow, entered the univerſity in 1691; and proſecuted the ſtudy of the languages and the different branches of philoſophy, till he became a ſtudent of theology under the tuition of his father. He was choſen librarian to the univerſity in the year 1698, and continued in that office four years. There he began his reſearches into every thing connected with the eccleſiaſtical hiſtory of his country, which he continued to purſue to the end of his life; and alſo imbibed his taſte for medals, inſcriptions, and whatever ſeemed curious or illuſtrative of Roman, Celtic, and Britiſh antiquities.

He was among the firſt in Scotland who attended to the ſtudy of natural hiſtory. From a great number of letters in his own hand writing, begun about this time, it appears that he was in habits of the utmoſt intimacy with a ſelect number of literary gentlemen, animated with the ſame ardour of reſearch; that they correſponded regularly with one another, made collections of ſingular ſtones, of foſſils, petrified plants, fiſhes, &c. and exchanged what they could ſpare from their reſpective ſtores. Among his correſpondents were Mr William Nicolſon, archdeacon, afterwards biſhop of Carliſle, and at laſt of Derry, author of the Hiſtorical Libraries; Mr Edward Lhwyd keeper of the Aſhmolean cloſet at Oxford; Sir Robert Sibbald, phyſician in Edinburgh, author of a natural hiſtory of Scotland, and another of Fife; Lord Pitmedan; Meſſrs James Sutherland, Laughlan Campbell miniſter of Campbelton, and others. In a letter to Mr Lhwyd dated Auguſt 1709, Mr Wodrow tells him his manſe was but at a little diſtance from a place where they had been lithoſcoping together, during a viſit of Mr Lhwyd to Scotland. "My parochial charge (he continues) does not allow me the ſame time I had then for thoſe ſubterranean ſtudies; but my inclination is equally ſtrong, perhaps ſtronger. I take it to be one of the beſt diverſions from ſerious ſtudy, and in itſelf a great duty, to admire my Maker's works. I have gotten ſome ſtore of foſſils here from our marle, limeſtone, &c. and heartily wiſh I had the knowing Mr Lhwyd here to pick out what he wants, and help me to claſs a great many ſpecies which I know not what to make of." He informs him, in the end of the letter, that he had 500 or 600 ſpecies of one thing or another relative to natural hiſtory.

Mr Wodrow, when he left Glaſgow, reſided a ſhort time in the neighbourhood, in the houſe of a very diſtant relation, Sir ——— Maxwell of Nether Pollock, then one of the Scots judges. It being within the bounds of the preſbytery of Paiſley, he offered himſelf to them for probationary trials, and obtained their licence to preach the goſpel in March 1703. In the ſummer following, the pariſh of Eaſtwood, where Lord Pollock lived, becoming vacant, by the death of Mr Matthew Crawford (another Scots hiſtorian), a petition, with an unanimous *call* or invitation from the pariſh to Mr Wodrow to be their miniſter, was preſented to the preſbytery ; and they, waving part of the uſual ſecond trials, in order to expedite the buſineſs, ordained Mr Wodrow to be miniſter of Eaſtwood on the 28th of October 1703. In this charge he continued to the end of his life. Notwithſtanding his miniſterial duty, he ſtill found ſome time to gratify the early bent of his mind towards natural hiſtory, and his curioſity to learn every thing in his power, not only at home, but concerning the natural productions of other countries, and the opinions, cuſtoms, manners, and way of living of their inhabitants. In his farewell letters to his friends, about to ſail to the Scottiſh ſettlement of Darien or to the coaſt of Africa, &c. he directed their attention and enquiries to theſe ſubjects ; and ſomething ſimilar he ſuggeſted to other friends going to reſide in remote places of the Highlands, or even on the continent of Europe. The collection of his MS. letters bound up in five or ſix thick 8vo volumes, though reaching nearly to the end of his life, ſeems to conſiſt only of the firſt draught of his own letters to his friends, not a ſingle ſcrap is now to be found of their anſwers to him.

After his ordination, however, this worthy man, conſidering the duties of his office as his principal and only proper buſineſs, roſe into diſtinguiſhed reputation and uſefulneſs as a preacher, and was looked upon as one of the firſt clergymen in the weſt of Scotland. Humble and unambitious of public notice, he was well entitled to it, by his conſcientious and exemplary piety, his learning, not only in profeſſional, but in other branches of knowledge, his natural good ſenſe and ſolid judgement, his benevolent obliging ſpirit to all, his warm attachment to his friends, who formed a wide circle around him, and eſpecially his deep concern for the beſt intereſts of his people, and active exertions for their inſtruction and improvement. His weekly ſermons were all diſtinctly written out in long hand, and even his lectures in ſhorthand. Accuſtomed to regular compoſition, he had acquired an uncommon facility in it. His countenance and appearance in the pulpit was manly and dignified ; his voice clear and commanding, his manner ſerious and animated : theſe things, joined with the general prejudice in his favour, added to the impreſſion of the plain edifying diſcourſes he delivered, without papers, to his hearers ; and living in the near neighbourhood of Glaſgow his little church was often crowded, eſpecially when he diſpenſed the Lord's Supper, conſidered in Scotland as the principal religious ſolemnity.

Yet theſe talents, and this merited popularity which followed them, made little impreſſion on his own modeſt conſcientious mind ; for he choſe to continue in the obſcure country pariſh with which he was firſt connected, reſiſting all the attempts made by his friends or by ſtrangers to get him tranſlated into ſeveral other more honourable and opulent pariſhes, who were deſirous of the benefit of his miniſtry, however convenient the change might have proved for the education of his family. In the year 1712, the magiſtrates of Glaſgow invited him to be one of the miniſters of that city ; and in January 1717, a deputation from the town of Stirling did the ſame. On the other hand, the patron, heritors, and elders of his own pariſh, ſtrenuouſly oppoſed the tranſlation. The preſbytery, who had it in their power to have appointed it, found great difficulties in both caſes on the plea of the *majus bonum eccleſiæ* ; referred the deciſion in the firſt caſe to the ſynod, and in the laſt to the commiſſion of the General Aſſembly, and theſe courts thought proper to put no reſtraint on the miniſter's judgement or inclination, as he himſelf was certainly the beſt judge of his comparative uſefulneſs in two different ſituations.

Mr Wodrow was equally conſcientious and aſſiduous in the buſineſs of the eccleſiaſtical courts, as in his parochial duty. Notwithſtanding his ſtudious turn, he punctually attended the meetings of Preſbytery, Synod, and General Aſſembly, when elected, as he often was, a member of that court ; and alſo the commiſſions in November and March, which regularly met during that period of the church. His connexion with Lord Pollock made his journeys to Edinburgh eaſy : and after he began to collect materials for his voluminous hiſtory, his perſonal inſpection of the public records and of the various MSS. accumulated in the Edinburgh libraries, made his viſits to that capital frequent and neceſſary.

In common with the great body of the Preſbyterians, he had ſtrongly imbibed what are called Whig principles ; in other words, he was warmly attached to the conſtitutional liberties of the people, as eſtabliſhed by the revolution ſettlement. No wonder ! The dreadful perſecution and oppreſſion they had ſuffered during the two preceding reigns were ſtill freſh and galling to their minds : they conſidered the elevation of King William to the throne and the Hanover ſucceſſion, as the two chief bulwarks raiſed up by Providence, for the ſecurity both of their religion and liberty. They trembled at every dark appearance threatening to this ſecurity, ſuch as the death of King William. That cloud, however, was ſoon diſſipated by the perſeverance of the queen's miniſters in his views and meaſures, and the ſplendid victories of Marlborough and his allies over the armies of Louis XIV. But the elevation of the Tory miniſtry in the latter part of the queen's reign was a ſevere trial to the Scottiſh Preſbyterians, and involved the conſcientious part of their clergy in very ſerious difficulties and dangers. The oath of abjuration required at that time from clergymen, and enforced by civil penalties, and even the royal proclamation for a national thankſgiving, after the peace of Utrecht, preſſed hard upon the ſcrupulous conſciences of many of the clergy. The very language of the *oath* ſeemed to them dubious and jeſuitical, hoſtile to the elector of Hanover's newly acquired right to the crown, conferred on him by the parliament and the people ; and as to the other point, they had not freedom to lead their people, in a ſolemn thankſgiving to Heaven for a peace, termed ſafe and honourable, which they and the generality of their hearers conſidered as dangerous and diſgraceful. Mr Wodrow, as might be expected, was one of the recuſants of the oath : for nothing could move him to ſhuffle with his conſcience. At the ſame time the liberality and equity of his mind led him to judge candidly of the conſciences of others. Accordingly, he made every effort in his power to reconcile his clerical brethren, and his own people, to ſuch of the clergy as had the freedom to take it, and by ſo doing, had rendered themſelves obnoxious to popular prejudice and odium. With ſuch, this good man ſtill continued to live, not only in Chriſtian, but miniſterial communion ; endeavouring to ſoften and remove the prejudices againſt them, and, in as far as his influence reached, to revive and cheriſh a ſpirit of mutual forbearance. Many propoſals he made, and private meetings and conferences he held with his brethren, to prevent their differences from riſing, as they threatened to do, into a ſchiſm; to prevent them eſpecially from entering at all into the church courts; juſtly afraid of the ſparks of animoſity too apt to be kindled there. His endeavours and thoſe of his friends were ſeconded by the prudence of the ſuperior courts, eſpecially the commiſſion of the General Aſſembly. Whatever paſſed there in the way of admonition to the reſt of the church, breathed the ſpirit of mutual forbearance and love. How he managed the other difficult and delicate point, *the Thankſgiving*, in a conſiſtency with his duty, does not appear in his letters; nor is it now worth while to inveſtigate this as a trait of his character, which might be done, perhaps, from his MS. ſermons preached at the time. Only it is pleaſing to remark from the letters, that the ſame ſpirit of wiſdom and mild forbearance which animated the majority of the clergy in the weſt, ſeems alſo to have pervaded the officers of the crown, juſtices of the peace, and other civil magiſtrates in Scotland at the time. The oath was not preſſed on the recuſants, and the execution of the legal penalties incurred by the neglect of it avoided; for their general loyalty was undoubted.

A more ſevere ſtroke was inflicted on their adverſaries by the Tory miniſtry in the year 1710 by an act of the Britiſh parliament which reſtored patronage to its former full force. An act of the Scotch parliament paſſed after the Revolution had extracted the chief ſting of that grievance, by placing the election of the miniſter of every pariſh in the hands of the landed proprietors, called heritors, in conjunction with the elders, or members of the kirk-ſeſſion. A majority of that joint body, at a meeting appointed for the purpoſe, drew up a *call* or written invitation, which they ſubſcribed to a particular candidate to be their miniſter. This was preſented to the preſbytery of the bounds, the proper judges of his learning and moral character; and if theſe were found unexceptionable, he was ordained, or ſolemnly conſecrated and inſtalled into the office. This Scotch act having continued in force for twenty years, and being conceived to have become perpetual by the articles of the Union, was now repealed; and the choice of a miniſter to every pariſh was in effect placed in the power of a ſingle perſon, a patron, becauſe he had in fact the ſole power of nominating the only candidate who could enjoy the benefice.

Mr Wodrow was exceedingly averſe from the revival of the power of patronage; and in this he was influenced both by his political and religious principles. In his letters, he ſeems to have looked upon a patron of a pariſh, as a kind of hereditary deſpot; or at leaſt like a prince, who had no reſtraints laid on his prerogative, to prevent or check the abuſe of it. The paramount power or truſt committed to a patron, this conſcientious miniſter could not reconcile with the apoſtolical counſels, *to commit the keeping of religious truth to faithful men, able alſo to inſtruct others*. He thought it very improper to leave the choice of a religious inſtructor, in the firſt inſtance, to any ſingle perſon whatever, eſpecially to one generally a ſtranger to the circumſtances of the pariſhioners; one who had little knowledge, and therefore little ſympathy with them in their religious ſentiments and feelings. He was perſuaded that the purpoſes of edification, and the peace of the country, circumſtanced as Scotland then was, were much better ſecured by the reſtraints laid on a patron in the act 1690, that is, by admitting the two principal bodies of the pariſh to a participation with him in his choice, than by truſting it wholly to himſelf; and he threw out many judicious hints in his letters, and even ſchemes or propoſals to his brethren, on this difficult and important ſubject.

On the other hand, he wiſhed nothing to be attempted but in a conſtitutional way, in harmony with the civil power. Few men were ſo ſenſible as he was of the abuſes incident to popular government, either in church or ſtate, and of the danger of reſiſting, even unjuſt and oppreſſive laws, in a tumultuous or diſorderly manner. The Preſbyterian church, in the outward order or form of it, he viewed as a well regulated republic. He did not conſider the people in their individual capacity, as qualified to vote even on the choice of their own miniſter. The elders of the pariſh he looked upon as the repreſentatives of the people in the eccleſiaſtical courts; and their number, in his own congregation, he reſtricted to a very few, four or five at moſt, fit to aſſiſt him in the exerciſe of church diſcipline within the pariſh. The reſt of his ſeſſion were deacons, whoſe juriſdiction was confined to the care of the poor, viſiting the ſick, and diſtributing the bread and wine at the communion, but could not, like the former, be choſen to repreſent the pariſh in the preſbytery and ſuperior courts. In this ſenſe of the neceſſity of order and ſubordination, he perſevered to the end of his life. When, contrary to *his* judgement or vote, an unpopular brother was to be ordained in a pariſh within twelve or fifteen miles diſtant from Eaſtwood, in conſequence of a ſentence of the General Aſſembly, to be executed, perhaps with military aſſiſtance; this aged miniſter thought it his duty, regardleſs of perſonal danger or odium, to countenance the young brother, by joining with the reſt of the clergy in laying their hands on him, inviting him afterwards to his pulpit, and exerting any influence he had to conciliate the irritated minds of that pariſh.

The only publication for which the world is indebted to Mr Wodrow, is The Hiſtory of the Singular Sufferings of the Church of Scotland during the twenty-eight years immediately preceding the Revolution. It was written at a proper diſtance of time from the events it records; and printed at Edinburgh in the year 1721, in two large folio volumes, with two appendixes conſiſting of copies of the public records, and of many private, family, and perſonal papers, letters, &c. inſerted as vouchers of the hiſtorical facts. In collecting this great body of information, the author was aſſiſted by his friends, who chearfully ſeconded his own almoſt incredible induſtry and patience of reſearch. In conſequence of this, the book has more the appearance of a biographical, than of a hiſtorical work. It has, however, the form, and all the eſſentials of a regular hiſtory, divided into books, chapters, and ſections, with proper margins and indexes; written in a plain, rather too familiar ſtile, unavoidably interſperſed with Scoticiſms, yet theſe ſufficiently intelligible to an Engliſh reader. It exhibits a diſtinct ſketch of the characters both of the principal ſufferers, and of their perſecutors; of the ſprings of the perſecution, in the unjuſtifiable plans and meaſures of an arbitrary government; with the motives of the adviſers and executors of them. The unfortunate and innocent ſufferers, our author viewed in the light, not of a ſet of wild fanatics, as they were called by their contemporaries, and frequently too by later hiſtorians; many of them were moſt reſpectable for their rank in their country, as well as for their talents and virtues; but even thoſe in the lower ranks of ſociety, our author thought worthy of ſome public notice, as confeſſors and martyrs in the noble cauſe which they had eſpouſed, the ſupport of the rights of conſcience, and of national liberty.

The ſubject of the hiſtory is the moſt melancholy that could be choſen; a long and ſevere perſecution of a people, who had been guilty of nothing undutiful to their civil or eccleſiaſtical rulers; a ſeries of open acts of injuſtice and tyranny, perpetrated under the colour of law, and this with ſuch an increaſing and mercileſs violence, as to ſink the uſual ſpirit of a free people, and eaſily quaſh one or two feeble ill-timed attempts to reſiſt their oppreſſors. No wonder that the continued view of ſuch a wretched and melancholy ſcene, without any thing joyful to interrupt it, ſhould give a melancholy tinge to the mind of the writer, eaſily communicated to his readers. On the other hand ſome things have happily an oppoſite tendency. The maſs of biographical intelligence, though it muſt be confeſſed it is much too voluminous, and too minute for the management of any hiſtorian whatſoever, yet furniſhes a variety of anecdotes, which give ſome needful relaxation or relief to the ſympathy of the reader. Theſe indeed are in part the *ſimple annals of the poor*, without the varniſh or eaſy elegance of poliſhed life; but even in this ſhape they are not deſtitute, both of entertainment and inſtruction; and then the minuteneſs in the detail of names, of perſons, places, and other particular circumſtances, adds to the impreſſion of the facts, by placing their certainty beyond all reaſonable doubt.

If faithfully to record paſt facts, and tranſmit the knowledge of them to poſterity, be the principal duty of a hiſtorian, this Wodrow has certainly aimed at; and alſo to repreſs any feelings hoſtile to his fidelity and impartiality; in ſhort, to come as near as he was able to the motto prefixed to his volumes, *Nec ſtudio, nec odio.* Doubtleſs, like all other men, he had ſome political, and many theological prejudices, the laſt chiefly imbibed from education, and confirmed by too high a veneration for the characters of our firſt reformers;—prejudices which warped his perſonal opinions and feelings on both ſubjects. But he ſeems to have made a conſiderable effort to prevent his party prejudices from warping or perverting his judgement of the truth or falſehood of ſtubborn hiſtorical facts. Nothing almoſt oratorial enters into his narratives, though there is room for admiration, and much ſcope for juſt indignation; no exaggerated encomiums on his friends, or ſtrong opprobrious language in ſpeaking of his and their enemies, the unprovoked perſecutors of his church. He allows the facts which he has recorded to ſpeak for both, and tranſmit to poſterity a memorial to their honour or their infamy.

The chief fault of this hiſtorical collection already hinted at, is its minuteneſs, and exceſſive copiouſneſs. The prodigious multitude of facts it embraces, though different from one another in their circumſtances, are in other reſpects ſomewhat ſimilar. This muſt neceſſarily occaſion ſome repetition and ſatiety, eſpecially to a faſtidious reader, who has it, however, in his power to gratify his taſte by ſelecting what is moſt agreeable to it. Nevertheleſs a candid and patient reader can be at no loſs to form a proper judgement of the principal tranſactions of the period, from the authentic accounts of them before him, to appreciate the true characters of the actors, or of the motives and views from which they acted. And an inquiſitive and penetrating reader will be gratified by ſeeing not a little of the peculiar principles, opinions, ſentiments, habits, and manners of that age, as diſtinguiſhed from the preſent; and may thus eſtimate the gradual progreſs towards much noble and uſeful improvement; and on the other hand, the progreſs towards a very hurtful corruption and degeneracy of manners, which have both taken place during the laſt hundred and twenty years.

At the time of its firſt publication, the book met with leſs general attention than might have been expected in Scotland, and ſcarcely any attention in England, except from profeſſed readers. As it came to be more ſtudied, it was the more valued, except were there was an evident bias on the oppoſite ſide. Few can be at a loſs to ſee why ſuch hiſtorians as Hume, Macpherſon, and Dalrymple ſhould neglect or undervalue ſuch a book. Our later Scotch hiſtorians, Somerville and Laing, have done it more juſtice. In truth, there is a very near coincidence in their eſtimates of the characters they draw, and their accounts of the facts they relate, in common with Wodrow. But eſpecially our late illuſtrious patriot Charles Fox, whoſe high abilities, uncommon candour, and ſweetneſs of diſpoſition, almoſt remove the ſuſpected bias of his party ſpirit—Mr Fox has, in the hiſtorical fragment publiſhed ſince his death, given a very honourable teſtimony to the fidelity and accuracy of our hiſtorian. After mentioning the execution of three females, he adds, page 131. “To relate all the inſtances of cruelty which occurred would be endleſs. But it may be neceſſary to remark, that no hiſtorical facts are better aſcertained, than the accounts of them which are to be found in Wodrow. In every inſtance, where there has been an opportunity of comparing theſe accounts with the records, and other authentic monuments, they appear to be quite correct.”

The collection of the materials for writing the church hiſtory from the public records, and many other authentic ſources, muſt have coſt the author a prodigious labour and time. The pecuniary expence incurred was conſiderable, and ſcarcely refunded from the ſale of the book. The only neat profit, he has been heard to ſay, which accrued from it, was one or two hundred pounds that he received from the king, to whom it was dedicated.

The laſt twelve years of Mr Wodrow's life were chiefly occupied in drawing up a biography of the principal perſons concerned in introducing the reformation of religion into Scotland, and ſettling the different forms or modes of eccleſiaſtical government attempted to be eſtabliſhed there from the beginning to the end of that period, namely from about the year 1560 to 1660, when the printed hiſtory of the ſufferings commences. Had it pleaſed God to continue his uſeful life till this larger work was finiſhed, public curioſity would have been much gratified; for it contains the lives, not only of John Knox, George Buchanan, and others already well known, but the lives of a great number more, very learned, ingenious, reſpectable, and worthy men, ſcarcely at all known to the literary world; beſides a variety of anecdotes naturally entering into ſuch a work, illuſtrative of the hiſtory and the living manners of that age. Happily theſe manuſcript lives are ſtill preſerved, all written with his own pen, and ſome of the longeſt of them copied, probably during his laſt long illneſs, in a more legible hand. Whatever important or curious information they may contain, they are not fit for the preſs in their preſent ſtate. They are now depoſited in the library of the univerſity of Glaſgow.

Beſides writing the hiſtory and the biography, both extended by himſelf for publication, and two days every week regularly appropriated to his preparation for the pulpit, much of his time muſt have been occaſionally ſpent in writing letters, ſome of them like diſſertations, on theological and other literary ſubjects; for he correſponded with a very wide circle of acquaintances and friends in Scotland, England, and Ireland; and with a few on the continent and in North America.

His conſtitution in the firſt part of life was robuſt and ſtrong, his health in general good; but his ſtudious habits or conſtant reading, and eſpecially inceſſant writing, it is ſuppoſed, may have brought on the bodily complaint which occaſioned his death. In the latter end of the year 1731, a ſwelling about the ſize of a ſmall cheſnut appeared on his breaſt, near the collar bone. It was on the ſame place where a ſpark of fire had fallen when he was a child, and had then left a little lump and hardneſs like a large pea. About a month after the ſwelling began, it had increaſed to the ſize of a plumb, and in April 1732 was a large as a man's fiſt. It was attempted to be removed by cauſtic; the attempt failed. His body became greatly emaciated, and he gradually declined till his death, which happened on the 21ſt of March 1734. Supported by the teſtimony of a good conſcience, joined with the ſtrong conſolation and well-founded hope of the goſpel, he bore this long-continued ſevere diſtreſs with admirable fortitude, unabated piety and reſignation; never uttering a murmur, but behaving to his friends who came to ſee him, and to all about him, with much eaſe and affection; thus leaving, both in the active exertions of a uſeful life, and in his patient ſufferings at the cloſe of it, a very edifying example to his family and his flock. The day before his death, he gathered his children around his bed, gave each of them his dying bleſſing, with counſels ſuitable to their ages and circumſtances; laſt of all two boys, neither of them four years old, too young to underſtand and feel theſe marks of his affection, yet, after the example of the venerable patriarch, Gen. xlviii. 15. even them he drew to him, laid his hands upon their heads, and devoutly prayed, *that the God of his fathers, the angel who had redeemed him from all evil, would bleſs the lads.*

Mr Wodrow was married in the end of 1708, to Margaret Warner, grand daughter of the reverend Mr William Guthrie of Fenwick, well known in Scotland by his writings, and daughter of the reverend Patrick Warner, then living on his eſtate of Ardeer in Ayrſhire. Mr Warner, in the early part of his life, had been chaplain to the Eaſt India Company at Madras. After his return home, he was driven from his miniſtry and from the kingdom, by the perſecution of the privy council; but returned in conſequence of King James's indulgence, and became miniſter of Irvine. He had a perſonal interview on his laſt return with the prince of Orange at the Hague, a ſhort time before the Revolution, an account of which appears in the hiſtory, vol. ii. p. 604. Mr Wodrow had a family of 16 children, nine of whom, with his widow, ſurvived him in decent circumſtances, without any breach among them for above 25 years. The only remaining ſurvivor is the reverend Dr James Wodrow of Stevenſton in Ayrſhire.

Beſides his collection of foſſils, and a few Roman and Britiſh medals, Mr Wodrow left a valuable library of books, many volumes of pamphlets and alſo of manuſcripts written by others, ſent to him in preſents, or copied by his orders. The moſt valuable part of them is now in the advocates library, and in the repoſitories of the church at Edinburgh. His own manuſcript biography, as has been already ſaid, is in the library of the univerſity of Glaſgow.

WOLAW, a town in Germany, in Sileſia, and capital of a duchy of the ſame name. It is ſurrounded with ſtrong walls and a moraſs, and one part of the houſes are built with ſtone. The caſtle is alſo encompaſſed with deep ditches, and the greateſt part of the inhabitants are employed in a woollen manufactory. In 1709 a Proteſtant church was allowed to be built here. It is ſeated on the river Oder, 20 miles north-weſt of Breſlau, and 32 ſouth-eaſt of Glogau. E. Long. 16. 54. N. Lat. 51. 18.

WOLD, WELD, *DYERS Weed*. See RESEDA, BOTANY *Index*, and DYEING.

WOLF. See CANIS, MAMMALIA *Index*.

WOLF-Fiſh, or *Sea-Wolf*. See ANARRHICAS, ICHTHYOLOGY *Index*.

WOLF or *Woolf Poiſon*. See POISON.

WOLFE, MAJOR-GENERAL JAMES, was born at Weſterham in the county of Kent, about the beginning of the year 1726. His father was Lieutenant-general Edward Wolfe. He went into the army when very young; and applying himſelf with unwearied aſſiduity to the ſtudy of his profeſſion, ſoon became remarkable for his knowledge and his genius. He diſtinguiſhed himſelf at the battle of Lafelt when little more than 20, and received the higheſt encomiums from the commander in chief. After the peace he ſtill continued to cultivate the art of war. He contrived to introduce the greateſt regularity and the exacteſt diſcipline into his corps, and at the ſame time to preſerve the affection of every ſoldier. In 1758 he was preſent as a brigadier-general at the ſiege of Louiſbourg. He landed firſt on the iſland at the head of diviſion; and in ſpite of the violence of the ſurf, and the force and well directed fire of the enemy, drove them from their poſt with great precipitation. The ſurrender of the town, which happened ſoon after, was in a great meaſure owing to his activity, bravery, and ſkill. The fame which he acquired during this ſiege pointed him out to Mr Pitt, who was then miniſter, as the propereſt perſon to command the army deſtined to attack Quebec. This was the moſt difficult and the moſt arduous undertaking of the whole war. Quebec was the capital of the French dominions in North America; it was well fortified, ſituated in the midſt of a hoſtile country, and defended by an army of 20,000 men, regulars and militia, beſides a conſiderable number of Indian allies. The troops deſtined for this expedition conſiſted of ten battalions, making up altogether about 7000 men. Such was the army deſtined to oppoſe three times their own number, defended by fortifications, in a country altogether unknown, and in a late ſeaſon in that climate for military operations. But this little army, ſays an officer who was preſent at that expedition, and who has been ſo obliging as to communicate all the information we deſired, was always ſanguine of ſucceſs; for they were commanded by General Wolfe, who, by a very uncommon magnanimity and nobleneſs of behaviour, had attached the troops ſo much to his perſon, and inſpired them with ſuch reſolution and ſteadineſs in the execution of their duty, that nothing ſeemed too difficult for them to accompliſh. The admirable ſkill with which his meaſures were planned, and the prudence and vigour with which they were executed, are well known. He landed his army on the northern ſhore of the river St Lawrence in ſpite of the enemy, and forced them to a battle, in which they were completely defeated. The conſequence of this battle was the reduction of Quebec, and the conqueſt of Canada. In the beginning of the battle General Wolfe was wounded in the wriſt by a muſket-ball: he wrapt his handkerchief round it, continued to give his orders with his uſual calmneſs and perſpicuity, and informed the ſoldiers that the advanced parties on the front had his orders to retire, and that they needed not be ſurpriſed when it happened. Towards the end of the battle he received a new wound in the breaſt; he immediately retired behind the rear-rank ſupported by a grenadier, and laid himſelf down on the ground. Soon after a ſhout was heard; and one of the officers who ſtood by him exclaimed, "See how they run!" The dying hero aſked with ſome emotion, "Who run?" "The enemy (replied the officer); they give way every where." The general then ſaid, "Pray, do one of you run to Colonel Burton, and tell him to march Webb's regiment with all ſpeed down to Charles river, to cut off the retreat of the fugitives from the bridge. Now, God be praiſed, I ſhall die happy!" He then turned on his ſide, cloſed his eyes, and expired.

The death of General Wolfe was a national loſs univerſally lamented. He inherited from nature an animating fervour of ſentiment, an intuitive perception, an extenſive capacity, and a paſſion for glory, which ſtimulated him to acquire every ſpecies of military knowledge that ſtudy could comprehend, that actual ſervice could illuſtrate and confirm. This noble warmth of diſpoſition ſeldom fails to call forth and unfold all the liberal virtues of the ſoul. Brave above all eſtimation of danger; generous, gentle, complacent, and humane; the pattern of the officer, the darling of the ſoldier. There was a ſublimity in his genius which ſoared above the pitch of ordinary minds; and had his faculties been exerciſed to their full extent by opportunity and action, had his judgement been fully matured by age and experience, he would, without doubt, have rivalled in reputation the moſt celebrated captains of antiquity. His body was brought to England, and buried with military honours in Weſtminſter abbey, where a magnificent monument is erected to his memory.

Wolfe, *Chriſtian*, a celebrated German philoſopher, was born at Breſlau in 1679. After having been well inſtructed in the rudiments of learning and ſcience in his own country, Wolfe proſecuted his ſtudies ſucceſſively in the univerſities of Jena, Hamburgh, and Leipſic. At the age of 26 he had acquired ſo much diſtinction, that he was appointed profeſſor of mathematics, and ſoon afterwards of philoſophy in general, in the univerſity of Hall. After Leibnitz had publiſhed his *Theodicea*, Wolfe, ſtruck with the novelty of the edifice which that philoſopher had raiſed, aſſiduouſly laboured in the inveſtigation of new metaphyſical truths. He alſo digeſted the Elements of Mathematics in a new method, and attempted an improvement of the art of reaſoning, in a treatiſe On the Powers of the Human Underſtanding. Upon the foundation of Leibnitz's doctrine of Monads, he formed a new ſyſtem of Coſmology and Pneumatology, digeſted and demonſtrated in a mathematical method. This work, entitled Thoughts on God, the World, and the Human Soul, was publiſhed in the year 1719; to which were added, in a ſubſequent edition, Heads of Ethics and Policy.

Enfield's Hiſtory of Philoſophy, vol. ii.

Wolfe was now riſing towards the ſummit of philoſophical reputation, when the opinion which he entertained on the doctrine of neceſſity being deemed by his colleagues inimical to religion, and an oration which he delivered in praiſe of the morality of the Chineſe having given much offence, an accuſation of hereſy was publicly brought againſt him; and, though he attempted to juſtify himſelf in a treatiſe which he wrote on the ſubject of fatality, a royal mandate was iſſued in November 1723, requiring him to leave the Pruſſian dominions. Having been formerly invited by the landgrave of Heſſe-Caſſel to fill a profeſſor's chair in the univerſity of Caſſel, Wolfe now put himſelf under the patronage of that prince, who had the liberality to afford him a ſecure aſylum, and appointed him profeſſor of mathematics and philoſophy. The queſtion concerning the grounds of the cenſure which had been paſſed upon Wolfe was now every where freely canvaſſed; almoſt every German univerſity was inflamed with diſputes on the ſubject of liberty and neceſſity; and the names of Wolfians and Anti-Wolfians were every where heard. After an interval of nine years, the king of Pruſſia reverſed his ſentence of exile, and appointed him vice-chancellor of the univerſity of Hall; where his return was welcomed with every expreſſion of triumph. From this time he was employed in completing his Inſtitutes of Philoſophy, which he lived to accompliſh in every branch except policy. In 1745 he was created a baron by the elector of Bavaria, and ſucceeded Ludowig in the office of chancellor of the univerſity. He continued to enjoy theſe honours till the year 1754, when he expired. He poſſeſſed a clear and methodical underſtanding; which, by long exerciſe in mathematical inveſtigations, was particularly fitted for the employment of digeſting the ſeveral branches of knowledge into regular ſyſtems; and his fertile powers of invention enabled him to enrich almoſt every field of ſcience in which he laboured, with ſome valuable additions. The lucid order which appears in all his writings enables his reader to follow his conceptions with eaſe and certainty, through the longeſt trains of reaſoning.

WOLFENBUTTLE, a conſiderable town of Germany, in the circle of Lower Saxony, and duchy of Brunſwick, with a caſtle where the duke of Brunſwick Wolfenbuttle reſides. It is one of the ſtrongeſt places in Germany, though the fortifications want repairing in ſeveral places. There is an excellent library, kept in a building lately erected for that purpoſe, conſiſting of 116,000 printed books, and 2000 uncommon books, with a cabinet of curioſities, relating to natural hiſtory. It is ſeated on the river Ocker, five miles ſouth of Brunſwick, and 30 weſt of Halberſtadt. E. Long. 10. 42. N. Lat. 52. 18.

WOLFRAM, or TUNGSTEN. See TUNGSTEN, CHEMISTRY and MINERALOGY *Index*.

WOLFSPERG, a town of Germany, in Lower Carinthia, with a caſtle, on which the diſtrict about it depends, which is 20 miles in length, and 10 in breadth. It is ſeated on the river Lavand, at the foot of a mountain covered with wood, and full of wolves, from whence the town took its name. It is 36 miles eaſt of Clagenfurt. E. Long. 15. 0. N. Lat. 46. 56.

WOLGAST, a conſiderable town of Germany, in the circle of Upper Saxony, and in Pomerania, capital of a territory of the ſame name, with a caſtle, and one of the beſt and largeſt harbours on the Baltic ſea. It is a well-built place, ſubject to Sweden, and ſeated on the river Pſin. E. Long. 14. 4. N. Lat. 54. 1.

WOLLASTON, WILLIAM, deſcended of an ancient family in Staffordſhire, was born in 1659. He was in 1674 admitted a penſioner in Sidney college, Cambridge, where, notwithſtanding ſeveral diſadvantages, he acquired a great degree of reputation. In 1682, ſeeing no proſpect of preferment, he became aſſiſtant to the head maſter of Birmingham ſchool. Some time after, he got a ſmall lecture about two miles diſtant, but did the duty the whole Sunday; which, together with the buſineſs of a great free-ſchool for about four years, began to break his conſtitution. During this ſpace he likewiſe underwent a great deal of trouble and uneaſineſs, in order to extricate two of his brothers from ſome inconveniences, to which their own imprudence had ſubjected them. In 1688 affairs took a new turn. He found himſelf by a couſin's will entitled to a very ample eſtate: and came to London that ſame year, where he ſettled; chooſing a private, retired, and ſtudious life. Not long before his death, he publiſhed his treatiſe, entitled The Religion of Nature Delineated; a work for which ſo great a demand was made, that more than 10,000 were ſold in a very few years. He had ſcarcely completed the publication of it, when he unfortunately broke an arm; and this adding ſtrength to diſtempers that had been growing upon him for ſome time, accelerated his death; which happened upon the 29th of October 1724. He was a tender, humane, and in all reſpects worthy man; but is repreſented to have had ſomething of the iraſcible in his conſtitution and temperament. His Religion of Nature Delineated expoſed him to ſome cenſure, as if he had put a ſlight upon Chriſtianity, by laying ſo much ſtreſs, as he does in this work, upon the obligations of truth, reaſon, and virtue; and by making no mention of revealed religion. But this cenſure muſt have been the offspring of ignorance or envy, ſince it appears from the introduction to his work, that he intended to treat of revealed religion in a ſecond part, which he lived not to finiſh.

WOLSEY, THOMAS, a famous cardinal and archbiſhop of York, is ſaid to have been the ſon of a butcher at Ipſwich. He ſtudied at Magdalen college, Oxford, where he became acquainted with the learned Eraſmus; and in the year 1500 became rector of Lymington in Somerſetſhire: he was afterwards made chaplain to King Henry VIII. and obtained ſeveral preferments. Having gradually acquired an entire aſcendency over the mind of Henry VIII. he ſucceſſively obtained ſeveral biſhoprics, and at length was made archbiſhop of York, lord high-chancellor of England, and prime miniſter; and was for ſeveral years the arbiter of Europe. Pope Leo. X. created him cardinal in 1515, and made him *legate à latere;* and the emperor Charles V. and the French king Francis I. loaded him with favours, in order to gain him over to their intereſt; but after having firſt ſided with the emperor, he deſerted him to eſpouſe the intereſt of France. As his revenues were immenſe, his pride and oſtentation were carried to the greateſt height. He had 500 ſervants; among whom were 9 or 10 lords, 15 knights, and 40 eſquires. His ambition to be pope, his pride, his exactions, and his political delay of Henry's divorce, occaſioned his diſgrace. In the earlier part of his life he ſeems to have been licentious in his manners; it was reported, that ſoon after his preferment to the living of Lymington in Somerſetſhire, he was put into the ſtocks by Sir Amias Paulet, a neighbouring juſtice of the peace, for getting drunk and making a riot at a fair. This treatment Wolſey did not forget when he arrived at the high ſtation of lord-chancellor of England; but ſummoned his corrector up to London, and, after a ſevere reprimand, enjoined him ſix years cloſe confinement in the Temple. Whatever may have been his faults, there can be no doubt of their having been aggravated both by the zealous reformers and by the creatures of Henry VIII. who was himſelf neither Papiſt nor Proteſtant; for there is every reaſon to believe that the cardinal was ſincere in his religion; and ſincerity, or at leaſt conſiſtency, was then a crime. Wolſey was the patron of learned men; a judge and munificent encourager of the polite arts; and ought to be conſidered as the founder of Chriſtchurch college, Oxford; where, as well as in other places, many remains of his magnificent ideas in architecture ſtill exiſt. He died in 1530.

WOLVERENE. See URSUS, MAMMALIA *Index*.

WOLVES TEETH, of a horſe. See FARRIERY.

WOMAN, the female of the human ſpecies. See HOMO.

WOMB, or UTERUS. See ANATOMY, N° 108.

WOMBAT, an animal lately diſcovered in New South Wales. See DASYURUS, MAMMALIA *Index*.

WOOD, ANTHONY, an eminent biographer and antiquarian, was the ſon of Thomas Wood, bachelor of arts and of the civil law, and was born at Oxford in 1632. He ſtudied at Merton college, and in 1655 took the degree of maſter of arts. He wrote, 1, The Hiſtory and Antiquities of the Univerſity of Oxford; which was afterwards tranſlated into Latin by Mr Waſe and Mr Peers, under the title of *Hiſtoria et Antiquitates Univerſitatis Oxonienſis*, 2 vols folio. 2. *Athenæ Oxonienſes;* or an exact Account of all the Writers and Biſhops who have had their Education in the Univerſity of Oxford, from the Year 1500 to 1600, 2 vols folio; which was greatly enlarged in a ſecond edition publiſhed in 1721 by Biſhop Tanner. Upon the firſt publication of this work the author was attacked by the univerſity, in defence of Edward earl of Clarendon, lord high chancellor of England, and chancellor of the univerſity, and was likewiſe animadverted upon by Biſhop Burnet; upon which he publiſhed a Vindication of the Hiſtoriographer of the Univerſity of Oxford. He died at Oxford in 1695.

WOOD, a ſubſtance whereof the trunks and branches of trees conſiſts. It is compoſed of a number of concentric circles or zones, one of which is formed every year; conſequently their number correſponds to the age of the tree. Theſe zones vary in thickneſs according to the degree of vegetation that took place the year of their formation. They are alſo of different degrees of thickneſs in different parts, that part of the tree which is moſt expoſed to the ſun and beſt ſheltered growing faſteſt; hence in this country that part of the zone which looked towards the ſouth while the tree was growing is generally thickeſt. The innermoſt circle or zone is the one which was firſt formed, the outermoſt was formed the year before the tree was cut down. Theſe zones are at firſt very ſoft and tender, and harden by degrees as the tree becomes older: this is the reaſon that the middle of a tree is ſo often much better wood than the outſide of it.

The proper ligneous part of the wood conſiſts of longitudinal fibres, diſpoſed in faſciculi, and poſſeſſed of conſiderable hardneſs. It is this longitudinal direction of the fibres that renders it ſo much eaſier to cleave wood lengthwiſe, than acroſs the tree, or in any other direction. See PLANT and VEGETABLE PHYSIOLOGY.

For an account of the ingredients which enter into the compoſition of wood, ſee CHEMISTRY *Index*.

For the *Method of Staining or Dyeing Wood* ſee TURNING.

For more complete information concerning wood, ſee alſo TREE, and *STRENGTH of Materials*.

Foſſil WOOD. Foſſil wood, or whole trees, or parts of them, are very frequently found buried in the earth, and that in different ſtrata; ſometimes in ſtone, but more uſually in earth; and ſometimes in ſmall pieces looſe among the gravel. Theſe, according to the time they have lain in the earth, or the matter they have lain among, are found differently altered from their original ſtate; ſome of them having ſuffered very little change; and others being ſo highly impregnated with cryſtalline, ſparry, pyritical, or other extraneous matter, as to appear mere maſſes of ſtone, or lumps of the common matter of the pyrites, &c. of the dimenſions, and, more or leſs, of the internal figure, of the vegetable bodies into the pores of which they have made their way.

The foſſil woods have been arranged by Dr Hill into three kinds: 1. The leſs altered; 2. The pyritical; and, 3. The petrified.

Of the trees, or parts of them, leſs altered from their original ſtate, the greateſt ſtore is found in digging to ſmall depths in bogs, and among what is called *peat* or *turf earth*, a ſuſtance uſed in many parts of the kingdom for fuel. In digging among this, uſually very near the ſurface, immenſe quantities of vegetable matter of various kinds are found buried; in ſome places there are whole trees ſcarce altered, except in colour; the oaks in particular being uſually turned to a jetty black; the pines and firs, which are alſo very frequent, are leſs altered, and are as inflammable as ever, and often contain between the bark and wood a black reſin. Large parts of trees have alſo been not unfrequently met with unaltered in beds of another kind, and at much greater depths, as in ſtrata of clay and loam, among gravel, and ſometimes even in ſolid ſtone.

Beſides theſe harder parts of trees, there are frequently found alſo in the peat earth vaſt quantities of the leaves and fruit and catkins of the hazel and ſimilar trees: theſe are uſually mixed with ſedge and roots of graſs, and are ſcarce at all altered from their uſual texture. The moſt common of theſe are hazel-nuts; but there are frequently found alſo the twigs and leaves of the white poplar; and a little deeper uſually there lies a cracked and ſhattered wood, the crevices of which are full of a bituminous black matter: and among this the ſtones of plums and other ſtone-fruits are ſometimes found, but more rarely.

In this ſtate the fruits and larger parts of trees are uſually found: what we find of them more altered, are ſometimes large and long, ſometimes ſmaller and ſhorter branches of trees; ſometimes ſmall fragments of branches, and more frequently ſmall ſhapeleſs pieces of wood. The larger and longer branches are uſually found bedded in the ſtrata of ſtone, and are more or leſs altered into the nature of the ſtratum they lie in. The ſhorter and ſmaller branches are found in vaſt variety in the ſtrata of blue clay uſed for making tiles in the neighbourhood of London. Theſe are prodigiouſly plentiful in all the claypits of this kind, and uſually carry the whole external reſemblance of what they once were, but nothing of the inner ſtructure; their pores being wholly filled, and undiſtinguiſhably cloſed, by the matter of the common pyrites, ſo as to appear mere ſimple maſſes of that matter. Theſe fall to pieces on being long expoſed to moiſture; and are ſo impregnated with vitriol that they are what is principally uſed for making the green vitriol or copperas at Deptford and other places.

The irregular maſſes or fragments of petrified wood are principally of oak, and are moſt uſually found among gravel; though ſometimes in other ſtrata. Theſe are variouſly altered by the inſinuation of cryſtalline and ſtony particles; and make a very beautiful figure when cut and poliſhed, as they uſually keep the regular grain of the wood, and ſhow exactly the ſeveral circles which mark the different years growth. Theſe, according to the different matter which has filled their pores, aſſume various colours, and the appearance of the various foſſils that have impregnated them; ſome are perfectly white, and but moderately hard; others of a browniſh black, or perfectly black, and much harder; others of a reddiſh black, others yellowiſh, and others grayiſh, and ſome of a ferruginous colour. They are of different weights alſo and hardneſſes, according to the nature and quantity of the ſtoney particles they contain: of theſe ſome pieces have been found with every pore filled with pure pellucid cryſtal; and others in large maſſes, part of which is wholly petrified and ſeems mere ſtone, while the reſt is crumbly and is unaltered wood. That this alteration is made in wood, even at this time, is alſo abundantly proved by the inſtances of wood being put into the hollows of mines, as props and ſupports to the roofs, which is found after a number of years as truly petrified as that which is dug up from the natural ſtrata of the earth. In the pieces of petrified wood found in Germany, there are frequently veins of ſpar or of pure cryſtal, ſometimes of earthy ſubſtances, and often of the matter of the common pebbles: theſe fragments of wood ſometimes have the appearance of parts of the branches of trees in their natural ſtate, but more frequently they reſemble pieces of broken boards; theſe are uſually capable of a high and elegant poliſh.

Many ſubſtances, it is certain, have been preſerved in the cabinets of collectors, under the title of *petrified wood*, which have very little right to that name. But where the whole outer figure of the wood, the exact lineaments of the bark, or the fibrous and fiſtular texture of the ſtriæ, and the veſtiges of the utriculi and tracheæ or air-veſſels, are yet remaining, and the ſeveral circles yet viſible which denoted the ſeveral years growth of the tree, none can deny theſe ſubſtances to be real foſſil wood. See Petrifaction.

Dr Parry of Bath has recently inveſtigated the cauſes of the decay of wood, and the means of preventing it. For this purpoſe he recommends the application of a preparation of the reſinous kind, mixed with a certain portion of bees-wax. The proportion of the ingredients and the mode of mixing them are as follows: Take 12 ounces of roſin and 8 ounces of roll brimſtone, each coarſely powdered, and 3 gallons of train oil; heat them ſlowly, gradually adding 4 ounces of bees-wax, cut into ſmall bits. Frequently ſtir the liquor, which, as ſoon as the ſolid ingredients are diſſolved, will be fit for uſe. It is recommended to dreſs every part of the wood-work with this compoſition twice over before the parts are put together, and once afterwards; and a higher ſtate of preſervation is promiſed from its uſe than has yet been attained. It ſhould be obſerved, that in preparing this varniſh, it is adviſable, in order to prevent accidents, to uſe an earthen veſſel, and to make the fire in the open air.

Wood (*ſylva*), in *Ancient Geography*, a multitude of trees extended over a large continued tract of land, and propagated without culture. The generality of woods only conſiſt of trees of one kind.—The ancient Saxons had ſuch a veneration for woods, that they made them ſanctuaries.—It is ordained, that none ſhall deſtroy any wood, by turning it into tillage or paſture, &c. where there are two acres or more in quantity, on pain of forfeiting 40s. an acre, by 35 Henry VIII. c. 17. All woods that are felled at 14 years growth, are to be preſerved from deſtruction for eight years; and no cattle put into the ground till five years after the felling thereof, &c. 13 Eliz. c. 25. The burning of woods or underwood is declared to be felony; alſo thoſe perſons that maliciouſly cut or ſpoil timber-trees, or any fruit-trees, &c. ſhall be ſent to the houſe of correction, there to be kept three months, and whipt once a month.

Wood, *Engraving on*, is commonly executed on box; and in many caſes, engravings of this kind are uſed with advantage inſtead of copperplates. The art of cutting or engraving on wood is of very high antiquity; for Chineſe printing is a ſpecimen of it. Even in Europe, if credit be due to Papillon, this art was practiſed at a very remote period; for he mentions eight engravings on wood, entitled, "A repreſentation of the warlike actions of the great and magnanimous Macedonian king, the bold and valiant Alexander; dedicated, preſented, and humbly offered, to the moſt holy father, Pope Honorius IV. by us Alexander Alberic Cunio Chevalier, and Iſabella Cunio, &c." This anecdote, if true, carries the art of cutting in wood back to 1284 or 1285; for Honorius occupied the papal throne only during theſe two years. But this is not the remoteſt period to which ſome have carried the art in Europe; for the uſe of ſeals or ſignets being of very high antiquity, they imagine that the invention of wood-cuts muſt be coeval with them. The ſuppoſition is certainly plauſible, but it is not ſupported by proof. The earlieſt impreſſion of a wooden-cut, of which there is any certain account, is that of St Chriſtopher carrying an infant Jeſus through the ſea, in which a hermit is ſeen holding up a lanthorn to ſhew him the way; and a peaſant, with a ſack on his back, climbing a hill, is exhibited in the back ground. The date of this impreſſion is 1423. In the year 1430 was printed at Haerlem, "The hiſtory of St John the evangeliſt and his revelation, repreſented in 48 figures in wood, by Lowrent Janſon Coſter;" and, in 1438, Jorg Schappf of Augſburg cut in wood the hiſtory of the Apocalypſe, and what was called *The poor man's bible*.

A folio chronicle, publiſhed 1493 by Schedal, was adorned with a great number of wooden-cuts by William Plydenwurff and Michael Wolgemut, whoſe engravings were greatly ſuperior to any thing of the kind which had appeared before them. The latter was the preceptor of Albert Durer, whoſe admirable performances in this department of art are juſtly held in the higheſt eſteem even at the preſent day.

About this period it became the practice of almoſt all the German engravers on copper to engrave likewiſe on wood; and many of their wood cuts ſurpaſs in beauty the impreſſions of their copperplates. Such are the wood-cuts of Albert Aldtorfer, Hiſbel Pen, Virgil Soles, Lucas Van Cranach, and Lucas Van Leyden, the friend and imitator of Albert Durer, with ſeveral others.

The Germans carried this art to a great degree of perfection. Hans or John Holbein, who flouriſhed in 1500, engraved the *Dance of Death*, in a ſeries of wooden-cuts, which, for the freedom and delicacy of execution, have ſcarcely been equalled, and never ſurpaſſed. Italy, France, and Holland, have produced capital artiſts of this kind. Joan. Tornæſium printed a bible at Leyden, in 1554, with wooden-cuts of excellent workmanſhip. Chriſtopher Jegher of Antwerp, from his eminence in the art, was employed by Rubens to work under his inſpection, and he executed ſeveral pieces which are held in much eſtimation; they are particularly diſtinguiſhed for boldneſs and ſpirit.

The next attempt at improvement in this art was by Hugo da Carpi, to whom is attributed the invention of the *chiaro ſcuro*. Carpi was an Italian, and of the 16th century; but the Germans claim the invention alſo, and produce in evidence ſeveral engravings by Mair, a diſciple of Martin Schoen, of date 1499. His mode of performing this was very ſimple. He firſt engraved the ſubject upon copper, and finiſhed it as much as the artiſts of his time uſually did. He then prepared a block of wood, upon which he cut out the extreme lights, and then impreſſed it upon the print; by which means a faint tint was added to all the reſt of the piece, excepting only in thoſe parts where the lights were meant to predominate, which appear on the ſpecimens extant to be coloured with white paint. The drawings for this ſpecies of engraving were made on tinted paper with a pen, and the lights were drawn upon the paper with white paint.

But there is a material difference between the chiaro ſcuro of the old German maſters and that of the Italians. Mair and Cranach engraved the outlines and deep ſhadows upon copper. The impreſſion taken in this ſtate was tinted over by means of a ſingle block of wood, with thoſe parts hollowed out which were deſigned to be left white upon the print. On the contrary, the mode of engraving by Hugo da Carpi was, to cut the outline on one block of wood, the dark ſhadows upon a ſecond, and the light ſhadows, or half-tint, upon a third. The firſt being impreſſed upon the paper, the outlines only appeared: this block being taken away, the ſecond was put in its place, and being alſo impreſſed on the paper, the dark ſhadows were added to the outlines; and the third block being put in the ſame place upon the removal of the ſecond, and alſo impreſſed upon the paper, made the dim tints, when the print was completed. In ſome inſtances, the number of blocks was increaſed, but the operation was ſtill the ſame, the print receiving an impreſſion from every block.

In 1698, John Baptiſt Michel Papillon practiſed engraving on wood with much ſucceſs, particularly in ornamental foliage and flowers, ſhells, &c. In the opinion, however, of ſome of the moſt eminent artiſts, his performances are ſtiff and cramped. From that period the art of engraving on wood gradually degenerated, and may be ſaid to have been wholly loſt, when it was lately re-invented by Mr Bewick of Newcaſtle. This eminent artiſt was apprentice to Mr Bielby, a reſpectable engraver on metal. Mr Bielby, who was accuſtomed to employ his apprentices in engraving on wood, was much gratified with the performance of Thomas Bewick, and therefore adviſed him to proſecute engraving in that line. The advice was followed; and young Bewick inventing tools, even making them with his own hands, and ſawing the wood on which he was to work into the requiſite thickneſs, proceeded to improve upon his own diſcoveries, without aſſiſtance or inſtruction of any kind. When his apprenticeſhip expired, he went to London, where the obſcure wood-engravers of the time wiſhed to avail themſelves of his abilities, while they were determined to give him no inſight into their art. During his apprenticeſhip, he received from the Society for the Encouragement of Arts, &c. a premium of conſiderable value for the beſt engraving in wood. The cut which obtained the premium was one of a ſeries for an edition of Gay's Fables. Having remained ſome years in London, he returned to Newcaſtle, and entered into copartnerſhip with his old maſter; and eſtabliſhed his reputation as an artiſt by the publication of his admirable Hiſtory of Quadrupeds. This was followed by his Hiſtory of Birds, in 2 vols. The greater part of the volume on Quadrupeds, and the whole of the firſt volume of the work on Birds, was compoſed by Mr Bielby.

John Bewick, brother to Thomas, learned the art of him, and practiſed it for ſeveral years in London with great applauſe. His abilities, however, though reſpectable, were not, by the beſt judges, deemed ſo brilliant as his brother's; and owing to bad health, and the nature of his connection with the bookſellers and others, he ſeems not to have advanced the art beyond the ſtage at which he received it. He died, ſome years ago, at Newcaſtle.

Mr Neſbit, who executed the admirable cuts from deſigns by Thornton, for an edition of Hudibras, as well as the cuts for editions of Shakeſpeare and Thomſon's Seaſons, and Mr Anderſon, whoſe beautiful cuts adorn the poem entitled *Grove Hill*, have been the moſt ſucceſsful of Thomas Bewick's pupils, who have appeared before the public as artiſts. It appears, that the method practiſed by the ancient engravers on wood, whoſe works are ſtill admired, muſt have been different from that of Bewick and his pupils. What that method was ſeems to be altogether unknown. Papillon, who writes the beſt hiſtory extant of the art, gueſſes indeed in what manner the old engravers proceeded ſo as to give to their works the ſpirit and freedom for which they are famed; but that his gueſſes are erroneous ſeems evident from the ſtiffneſs of his own works. The principal characteriſtic in the mechanical department of the productions of the ancient maſters is the croſſing of the black lines, which Papillon has attempted with the greateſt awkwardneſs, though it ſeems to have been accompliſhed by them with ſo much eaſe, that they introduced it at random, even where it could add nothing to the beauty of the piece. In Bewick's method of working, this croſs hatching is ſo difficult and unnatural, that it may be conſidered as impracticable. Mr Neſbit has indeed introduced ſomething of it into two or three of his pieces; but ſo great was the labour, and ſo little the advantage of this improvement, if ſuch it can be called, that probably it will not be attempted again.

The engravers of Bewick's ſchool work on the end of the wood, which is cut acroſs the trunk of the tree, in pieces of the proper thickneſs. As wood-cuts are generally employed in the printer's preſs amidſt a form of types, this thickneſs muſt be regulated by the height of the types with which they are to be uſed. The tools employed are nearly the ſame with thoſe uſed in copperplate engraving, being only a little more deep, or lozenge, as engravers call it. They muſt have points of various degrees of fineneſs for the different purpoſes to which they are applied, ſome of them being ſo much rounded off at the bottom as to approach to the nature of a goodge, whilſt others are in fact little chiſſels of various ſizes. Theſe chiſſels and goodges, to which every artiſt gives the ſhape which he deems moſt convenient, are held in the hand in a manner ſomewhat different from the tool of the engraver on copper, it being neceſſary to have the power of lifting the chips upwards with eaſe. To attempt a deſcription of this in writing would be in vain; but it is eaſily acquired, we are told, by practice.

The pupils of the ſchool of Bewick conſider it as quite improper to ſpeak of his invention as a revival of the ancient art. Some old prints, it is true, have the appearance of being executed in the ſame way with his; but others have certainly been done by a method very different. It is therefore not fair to appreciate the preſent art by what has been done, but by what may be done; and that remains yet to be ſhewn. The art is in its infancy; and thoſe who are diſpoſed to compare it with the art of engraving on copper, ought to look back to the period when copperplate engraving was of as recent invention as Bewick's method of engraving on wood. Marc Antonio, who engraved under the direction of the great painter Raphael, thought it no mean proof of his proficiency in his art, that he was able to imitate on copperplates the wood-cuts of Albert Durer; and Papillon is highly indignant that there ſhould have been perſons ſo very blind as to miſtake the copies for the originals. If copper has its advantages

vantages over wood in point of delicacy and minuteneſs, wood has, in its turn, advantages not inferior in regard to ſtrength and richneſs. Thoſe prints which were executed under the auſpices of Titian and Rubens, will always remain a monument of the ſpirit and vigour natural to wood-engraving; and if there be not found in them all the attention to chiaro ſcuro, which the preſent age demands, it muſt not be attributed either to defect in the art, or to want of abilities in the artiſts, but to the taſte of the times when chiaro ſcuro was little underſtood. It remains for ſome enterpriſing artiſt to ſhew that the vigour of the ancient art may be attained by the preſent one, and at the ſame time to add to that vigour thoſe gradations of ſhade which are ſo much admired in good copperplates. As there ſeems to be a more perfect, or at leaſt a more pleaſant black produced by wood than by copperplate printing, and certainly a more perfect white (A), who will ſay that any intermediate ſhade whatever may not be produced by wood-cuts? To attempt this on a ſmall ſcale would indeed be vain, becauſe the ſlighteſt variation, produced by a little more or leſs ink, or a harder preſſure in printing, bears ſuch a proportion to a very ſhort line, as muſt neceſſarily render the attempt abortive.

Wood-engraving, therefore, muſt always appear to diſadvantage while it is confined to ſmall ſubjects, and will never reach its ſtation *as a fine art*, till thoſe who are engaged in its cultivation improve upon the diſcoveries of one another, and apply to ſubjects to which it is properly adapted. As an *economical art* for illuſtrating mechanics, various branches of natural hiſtory, and other ſubjects of ſcience, it is too little employed even in its preſent ſtate.

The works of Bewick and his pupils, which have hitherto been publiſhed, are not numerous. Beſides his quadrupeds and birds, the Hudibras, and the cuts for ſome editions of Shakeſpeare and Thomſon's Seaſons, by Neſbit, and the Grove Hill by Anderſon, already noticed, there are alſo ſome others of leſs note.—Goldſmith's Traveller and Deſerted Village with elegant plates, are all executed by Thomas Bewick, except one or two which were executed by John; Somerville's Chace by the ſame artiſts, executed in a ſtyle of elegance which perhaps has never been ſurpaſſed; a View of St Nicholas's Church, Newcaſtle, 15 inches long, by Mr Neſbit, who received for it a ſilver medal from the Society for the Encouragement of Arts.

Wood, Rotten, Illumination of. This is a ſubject which has often been diſcuſſed by naturaliſts. Spallanzani maintained, that there is a perfect analogy between the illumination of rotten wood, and artificial phoſphorus; and he imagines, that in the putrid fermentation, the hydrogen and the carbone of the wood come more eaſily in contact with the oxygen of the atmoſphere, by which combination a ſlow combuſtion, and the illumination of the wood, is produced; and he thinks that this proceſs cannot proceed in the irreſpirable kinds of gaſes. Rotten wood alſo, in which the neceſſary quantity of hydrogen and carbone is not at the ſame time diſengaged, does not obtain the property of illuminating. Mr Corradori, however, objects to this theory, that the ſlow combuſtion does not take place according to the above theory, as the wood, at the time when it begins to illuminate, is moſtly deprived of its reſinous particles, and conſequently contains but very little hydrogen and carbone; and it appears to him more probable, that the more it loſes of combuſtible matter, the more it obtains the property of illuminating. There is, he thinks, a very great difference between this natural and the artificial phoſphorus. Mr Humboldt concludes, from his experiments, that the illumination of rotten wood takes place only when it gets into contact with oxygen; and when it has loſt the property of emitting light in irreſpirable gaſes, it recovers it again by expoſing it to oxygen gas. Dr Gartner, however, is of opinion, that, according to his experiments, a certain degree of humidity is always requiſite, and he thinks that oxygen gas is not quite neceſſary though the illumination be increaſed by it. This phenomenon, however, being ſo very different from all known proceſſes of combuſtion, where light is diſengaged, Dr Gartner aſks, whether it be not more agreeing with the animal proceſs of reſpiration, than with a true combuſtion, or whether the illumination of the wood be produced by phoſphorus and carbone in a proportion hitherto unknown. Dr Gartner is, on the whole, inclined to think, that it is at preſent impoſſible to give a ſatisfactory explanation of all the phenomena that occur in this proceſs. Beckmann has made numerous experiments on the illumination of rotten wood, in different gaſes and fluids, in order to throw ſome light on the ideas of the above naturaliſts. The reſults of theſe experiments differ in ſome points from what the experiments of thoſe gentlemen have ſhewn, which, however, Beckmann aſcribes to the nature of rotten wood, as a ſubſtance that is not always of the ſame kind, and has not always an equal degree of putrefaction and humidity. It ſeems alſo to differ materially from the artificial phoſphorus in the following particulars. 1. It ſhines in oxygen gas at a very low temperature. 2. It emits light in all irreſpirable gaſes, at leaſt for a ſhort time. 3. In muriatic acid gas its light is ſuddenly extinguiſhed. 4. It ſhines in a leſs degree in air rarefied by the air-pump. 5. According to Mr Corradori, it even ſhines in the torricellian vacuum. 6. Its illumination is extinguiſhed in oxygen gas, as well as in other kinds of gaſes, when they are heated. 7. By its illumination in oxygen gas, carbonic acid gas is produced. 8. One may ſuffer the rotten wood to be extinguiſhed ſeveral times, one after another, in irreſpirable gaſes, without depriving them of the property of making new pieces of rotten wood ſhine again. 9. Humidity greatly promotes the illumination, and even ſeems to be neceſſary in producing it. 10. The rotten wood continues to ſhine under water, oil, and other fluids, and in ſome of them its light is even increaſed. All this ſeems to ſhew, that the extinction of rotten wood, in different media, does not immediately depend on a want of oxygen, but rather on a particular change, to which the wood itſelf has been expoſed.

Wood-Cock. See SCOLOPAX, ORNITHOLOGY *Index*.

Wood-Goat. See CAPRA, MAMMALIA *Index*.

Wood-Louſe. See ONISCUS, ENTOMOLOGY *Index*.

(A) The parts of the print intended to be white are not even touched by the wood block.

Wood-Pecker. See Picus, Ornithology *Index*.

WOODMOTE. See *Forest Courts*.

WOODSTOCK, a town of Oxfordſhire, in England, pleaſantly ſeated on a riſing ground, and on a rivulet; a well compacted borough-town, and ſends two members to parliament; but is chiefly noted for Blenheim-houſe, a fine palace, built in memory of the victory obtained by the duke of Marlborough over the French and Bavarians in Auguſt 1704. It was erected at the public expence, and is one of the nobleſt ſeats in Europe. One of the paſſages to it is over a bridge with one arch, 190 feet in diameter, reſembling the Rialto at Venice. The gardens take up 100 acres of ground; and the offices, which are very grand, have room enough to accommodate 300 people. The apartments of the palace are magnificently furniſhed; and the ſtaircaſes, ſtatues, paintings, and tapeſtry, ſurpriſingly fine. The town is about half a mile from the palace, having ſeveral good inns; and a manufacture of ſteel chains for watches, and excellent gloves. A ſteel chain has been made at this place which ſold for 170l.—The population is eſtimated at 1300 perſons. It is eight miles north of Oxford, and 60 weſt-north-weſt of London. W. Long. 1. 15. N. Lat. 51. 52.

WOODWARD, Dr John, was born in 1665, and educated at a country ſchool, where he learned the Latin and Greek languages, and was afterwards ſent to London, where he is ſaid to have been put apprentice to a linen-draper. He was not long in that ſtation, till he became acquainted with Dr Peter Barwick, an eminent phyſician, who took him under his tuition and into his family. Here he proſecuted with great vigour and ſucceſs the ſtudy of philoſophy, anatomy, and phyſic. In 1692, Dr Stillingfleet quitting the place of profeſſor of phyſic in Greſham college, our author was choſen to ſucceed him, and the year following was elected F. R. S. In 1695 he obtained the degree of M. D. by patent from Archbiſhop Tenniſon; and the ſame year he publiſhed his Eſſay towards a Natural Hiſtory of the Earth. He afterwards wrote many other pieces, which have been well received by the learned world. He founded a lecture in the univerſity of Cambridge, to be read there upon his Eſſay, &c. and handſomely endowed it. He died in 1728.

WOOF, among manufacturers, the threads which the weavers ſhoot acroſs with an inſtrument called the *ſhuttle*. See Cloth.

WOOKEY or *OKEY Hole*, a remarkable cavern two miles from the city of Wells in Somerſetſhire; for an account of which, ſee the article Grotto.

WOOL, the covering of ſheep. See Ovis and Sheep.

Bee, vol. xviii. p. 57.

Wool reſembles hair in a great many particulars; but beſides its fineneſs, which conſtitutes an obvious difference, there are other particulars which may ſerve alſo to diſtinguiſh them from one another. Wool, like the hair of horſes, cattle, and moſt other animals, completes its growth in a year, and then falls off as hair does, and is ſucceeded by a freſh crop. It differs from hair, however, in the uniformity of its growth, and the regularity of its ſhedding. Every filament of wool ſeems to keep exact pace with another in the ſame part of the body of the animal; the whole crop ſprings up at once; the whole advances uniformly together; the whole looſens from the ſkin nearly at the ſame period, and thus falls off, if not previouſly ſhorn, leaving the animal covered with a ſhort coat of young wool, which in its turn undergoes the ſame regular mutations.

Hairs are commonly of the ſame thickneſs in every part; but wool conſtantly varies in thickneſs in different parts, being generally thicker at the points than at the roots. That part of the fleece of ſheep which grows during the winter is finer than what grows in ſummer. This was firſt obſerved by Dr Anderſon, the editor of the Bee, and publiſhed in his *Obſervations on the Means of exciting a Spirit of National Induſtry*.

While the wool remains in the ſtate it was firſt ſhorn off the ſheep's back, and not ſorted into its different kinds, it is called *fleece*. Each fleece conſiſts of wool of divers qualities and degrees of fineneſs, which the dealers therein take care to ſeparate. The French and Engliſh uſually ſeparate each fleece into three ſorts, viz. 1. Mother-wool, which is that of the back and neck. 2. The wool of the tails and legs. 3. That of the breaſt and under the belly. The Spaniards make the like diviſion into three ſorts, which they call *prime*, *ſecond* and *third*; and for the greater eaſe, mark each bale or pack with a capital letter, denoting the ſort. If the triage or ſeparation be well made, in 15 bales there will be 12 marked R, that is, refine, or prime; two marked F, for fine, or ſecond; and one S, for thirds.

The wools moſt eſteemed are the Engliſh, chiefly thoſe about Leominſter, Cotſwold, and the iſle of Wight; the Spaniſh, principally thoſe about Segovia; and the French, about Berry: which laſt are ſaid to have this peculiar property, that they will knot or bind with any other ſort; whereas the reſt will only knot with their own kind.

Among the ancients, the wools of Attica, Megara, Laodicea, Apulia, and eſpecially thoſe of Tarentum, Parma, and Altino, were the moſt valued. Varro aſſures us, that the people there uſed to clothe their ſheep with ſkins, to ſecure the wool from being damaged.

Of late a great deal of attention has been paid to wool in this country, as well as ſeveral others. Several very ſpirited attempts have been made to improve it, by introducing ſuperior breeds of ſheep, and better methods of managing them. For this purpoſe has been formed the

Britiſh Wool Society, an aſſociation formed for the purpoſe of obtaining the beſt breeds of fine-woolled ſheep, with a view of aſcertaining, by actual experiments, how far each ſpecies or variety is calculated for the climate of Great Britain; the qualities of their wool reſpectively; the uſes to which each kind of wool could be moſt profitably employed in different manufactures; and the comparative value of each ſpecies of ſheep, ſo far as the ſame can be determined.

Attention had for ſome time been paid by the Highland Society to a famous breed of fine woolled ſheep in Shetland; but it occurred to Sir John Sinclair of Ulbſter, baronet, and to Dr James Anderſon, well known as the author of many uſeful publications, that the improvement of Britiſh wool was a matter of too much importance to be entruſted to a ſociety which is obliged to devote its attention to ſuch a variety of objects as the general improvement of the Highlands of Scotland. The latter of theſe gentlemen, therefore, in an Appendix to the Report of the Committee of the Highland Society

Society of Scotland, for the year 1790, propoſed *the plan of a patriotic aſſociation for the improvement of Britiſh wool;* and the former, who was convener of the committee to whom the ſubject of Shetland wool had been referred, wrote circular letters, recommending the plan. The conſequence of which was, that on the 31ſt of January 1791, ſeveral noblemen and gentlemen of the higheſt reſpectability met in Edinburgh, and conſtituted themſelves into a *Society for the Improvement of Britiſh Wool.* Of this ſociety Sir John Sinclair was elected preſident; after which, in an excellent ſpeech, he pointed out to the members the objects of the inſtitution, the means by which thoſe objects could be attained, and the advantages which would reſult from their united labours. This addreſs was afterwards printed by order of the ſociety.

The particular breeds of ſheep to which the ſociety propoſed to direct its attention, were ſheep for the hilly parts of Scotland; ſheep for the plains, or the Lowland breed; and ſheep for the iſlands. They were to try experiments alſo with ſheep from foreign countries, diſtinguiſhed by any particular property.

The principal objects which the members had in view, during the firſt year of their aſſociation, were, 1. To collect ſpecimens of the beſt breeds which Great Britain at that period afforded, in order to aſcertain the degree of perfection to which ſheep had already been brought in this kingdom. 2. To procure from every country, diſtinguiſhed for the quality of its ſheep and wool, ſpecimens of the different breeds it poſſeſſed, in order to aſcertain how far the original breed, or a mixed breed from it and the native ſheep of the country, could thrive in Scotland. 3. To diſperſe as much as poſſible all theſe breeds, both foreign and domeſtic, over the whole kingdom, wherever proper perſons could be found to take charge of them, in order to try experiments on a more extenſive ſcale than the ſociety itſelf could do; to ſpread information, and to excite a ſpirit for the improvement of ſheep and wool in every part of the country.

Sir John Sinclair had previouſly collected a flock, conſiſting of ſheep of the Spaniſh, Herefordſhire, Southdown, Cheviot, Lomond hills, and Shetland breeds, and of a mixed breed from theſe different ſheep. This flock amounted to 110 rams, ewes, and lambs. M. d'Aubenton, in conſequence of a correſpondence with Sir John Sinclair, ſent over to the ſociety ten rams and five ewes, of real Spaniſh breed, which had been originally entruſted to his care by the late king of France: theſe, after encountering a number of obſtacles, and after being ſtopped and threatened to be ſlaughtered at the cuſtomhouſe of Brighthelmſtone for the uſe of the poor, arrived ſafe at Leith. Lord Sheffield, at the ſame time, ſent to the ſociety four rams and ſix ewes of the Southdown and Spaniſh breeds. Mr Biſhton of Kilſall, in Shropſhire, preſented them with three Hereford rams, reckoned by many the beſt breed in England; the ſociety at the ſame time ordered 150 ewes of the ſame breed, and two ewes of the Long Mountain breed, reckoned the beſt in Wales, to be ſent along with them. They purchaſed 57 rams and 173 ewes of the Cheviot breed, reckoned the beſt in Scotland, for the hilly parts of the country. Lord Daer ſent them 20 ewes of an excellent breed, which exiſted at Mochrum in Galloway. The late earl of Oxford ſent them in a preſent three rams of the Norfolk croſſed by the Cape of Good Hope breed. Mr Iſaac Grant junior of Leghorn, in conjunction with Mr Sibbald, merchant at Leith, preſented them an Apulian ram and ewe; the ram arrived in ſafety, but the ewe unfortunately died on the paſſage. Mr Baron Seton of Preſton, in Linlithgowſhire, ſent them a ram and two ewes of a Spaniſh breed, which had been for ſome time kept in Sweden unmixed with any other. They purchaſed 100 ewes of a ſmall breed exiſting in the pariſh of Leuchars in Fife, much reſembling the Shetland. The Right Honourable William Conynghame of Ireland ſent them 11 Spaniſh rams, ſeven Spaniſh ewes, 15 three-fourth breed and 16 one-half breed Spaniſh and Iriſh ewes. Lord Sheffield ſent them eight rams and 18 ewes; and his Majeſty made them a preſent of two rams.

Thus, in the courſe of one year, the ſociety acquired by donation or purchaſe about 800 ſheep of different ſorts and ages, and many of them from foreign countries: about 500 of theſe were diſtributed over different parts of Scotland, the greater number of which were ſold to gentlemen anxious to promote the views of the ſociety, and well qualified to make experiments on the different breeds which they had obtained. The greateſt part of the remainder were taken by different gentlemen who kept them for the ſociety, and according to their directions, without any expence.

It is impoſſible to produce an inſtance of ſo much having been accompliſhed by a ſociety of private individuals in ſo ſhort a time. Nor was this all; the ſame year Mr Andrew Kerr, a very intelligent ſheep-farmer on the borders of England, was ſent, at the expence of the ſociety, to examine the ſtate of ſheep-farming along the eaſt coaſt of Scotland and the interior parts of the Highlands. His tour was printed by order of the ſociety, and contains the firſt intimation of the poſſibility of the Cheviot breed thriving in the north of Scotland.

In the year 1792, Meſſrs Redhead, Laing, and Marſhall, were ſent by the ſociety, to make a ſurvey of the ſtate of ſheep-farming through ſome of the principal counties of England; the reſult of which was alſo publiſhed by the ſociety, and contains more information on the ſubject of the different breeds of England than any work hitherto publiſhed; and in 1794, Mr John Naiſmyth was ſent on a tour through the ſouthern diſtricts of Scotland, which completed the circuit of almoſt the whole kingdom.

Thus a few private individuals, unaided by the public purſe, had boldneſs enough to undertake aſcertaining the comparative value of the different kinds of ſheep in their own country, and to introduce ſome of the moſt celebrated breeds of other countries, and ſucceeded in the ſpirited attempt. It is impoſſible in this place to ſtate more minutely the various other tranſactions of the ſociety; to enter into any detail of the premiums given by this reſpectable inſtitution for the improvement of the celebrated Shetland breed; or to explain how, as if it were by magic, in a country where the manufacture of wool was little known, articles manufactured of that material were made, rivalling, and in ſome caſes ſurpaſſing, the moſt celebrated fabrics of other countries. A war having unfortunately ariſen, it became impoſſible to pay the ſame attention, or to carry on with the ſame ſucceſs, novel enterpriſes; even old

old eſtabliſhments often fall a ſacrifice amidſt the horrors of war. The utmoſt that the Britiſh Wool Society could expect to do, was to preſerve the inſtitution in ſuch a ſtate, that when peace ſhall be happily reſtored it may revive with double energy and ſpirit.

It is a curious fact that the Romans, during their reſidence in Britain, eſtabliſhed a manufactory of woollen cloth at Wincheſter, which was ſo extenſive as to ſupply their army; and there is reaſon to believe that the trade which they introduced into Britain, was not neglected by the native inhabitants, for the firſt 900 years of the Chriſtian era. The long Spaniſh wool was imported into this country ſo early as the 12th century, and we find that ſince the days of Edward III. Britiſh fleeces were admirably adapted to the kind of cloth which was in greateſt requeſt, though now they are generally unequal to the production of that which is ſought after.

Wool-Combing, a well known operation, which, when performed by the hand, is laborious, tedious, and expenſive. The expence of it through all England has been calculated at no leſs a ſum than 800,000l.; and to leſſen this expence, the Rev. Edmund Cartwright of Doncaſter in Yorkſhire bethought himſelf, ſome years ago, of carding wool by machinery. After repeated attempts and improvements, for which he took out three patents, he found that wool can be combed in perfection by machinery, of which he gives the following deſcription.

Plate DLXXVIII. Fig. 1. Fig. 1. is the crank laſher. A is a tube through which the material, being formed into a ſliver, and ſlightly twiſted, is drawn forward by the delivering rollers; B, a wheel faſt upon the croſs bar of the crank; C, a wheel, on the oppoſite end of whoſe axis is a pinion working in a wheel upon the axis of one of the delivering rollers.

Note. When two or more ſlivers are required, the cans or baſkets, in which they are contained, are placed upon a table under the laſher (as repreſented at D), which, by having a ſlow motion, twiſts them together as they go up.

Fig. 2. Fig. 3. Fig. 2. is the circular clearing comb, for giving work in the head, carried in a frame by two cranks. Fig. 3. the comb-table, having the teeth pointing towards the centre, moved by cogs upon the rim, and carried round upon trucks like the head of a windmill. *a*, *b*, The drawing rollers. *c*, *d*, Callendar, or conducting rollers.

Note. Underneath the table is another pair of rollers, for drawing out the backings.

In the above ſpecification, we have omitted the frame in which the machine ſtands, the wheels, ſhafts, &c. Had theſe been introduced, the drawing would have been crowded and confuſed; beſides, as matters of information, they would have been unneceſſary, every mechanic, when he knows the principles of a machine, being competent to apply the movements to it.

The wool, if for particularly nice work, goes through three operations, otherwiſe two are ſufficient: the firſt operation opens the wool, and makes it connect together into a rough ſliver, but does not clear it. The clearing is performed by the ſecond, and, if neceſſary, a third operation. A ſet of machinery, conſiſting of three machines, will require the attendance of an overlooker and ten children, and will comb a pack, or 240lb. in twelve hours. As neither fire nor oil is neceſſary for machine-combing, the ſaving of thoſe articles, even the fire alone, will, in general, pay the wages of the overlooker and children; ſo that the actual ſaving to the manufacturer is the *whole* of what the combing coſts, by the old imperfect mode of hand-combing. Machine-combed wool is better, eſpecially for machine-ſpinning, by at leaſt 12 per cent. being all equally mixed, and the ſlivers uniform, and of any required length.

WOOLSTON, Thomas, an Engliſh divine, was born at Northampton in 1669, and educated at Cambridge. His firſt appearance in the learned world was in 1705, in a work entitled, The Old Apology for the Truth of the Chriſtian Religion, againſt the Jews and Gentiles, revived. He afterwards wrote many pieces: but what made the moſt noiſe, were his ſix Diſcourſes on the Miracles of Chriſt; which occaſioned a great number of books and pamphlets upon the ſubject, and raiſed a proſecution againſt him. At his trial in Guildhall, before the lord chief-juſtice Raymond, he ſpoke ſeveral times himſelf; and urged, that "he thought it very hard that he ſhould be tried by a ſet of men who, though otherwiſe very learned and worthy perſons, were no more judges of the ſubjects on which he wrote, than himſelf was a judge of the moſt crabbed points of the law." He was ſentenced to a year's impriſonment, and to pay a fine of 100l. He purchaſed the liberty of the rules of the King's bench, where he continued after the expiration of the year, being unable to pay the fine. The greateſt obſtruction to his deliverance from confinement was, the obligation of giving ſecurity not to offend by any future writings, he being reſolved to write again as freely as before. Whilſt ſome ſuppoſed that this author wrote with the ſettled intention of ſubverting Chriſtianity under the pretence of defending it, others believed him diſordered in his mind; and many circumſtances concurred which gave countenance to this opinion. He died, January 27. 1732-3, after an illneſs of four days; and, a few minutes before his death, uttered theſe words: "This is a ſtruggle which all men muſt go through, and which I bear not only patiently, but with willingneſs." His body was interred in St George's church-yard, Southwark.

WOOLWICH, a town in Kent, with a market on Fridays, but no fair. It is ſeated on the river Thames, and of great note for its fine docks and yards, where men of war are built; as alſo for its vaſt magazines of great guns, mortars, bombs, cannon-balls, powder, and other warlike ſtores. It has likewiſe an academy, where the mathematics are taught, and young officers inſtructed in the military art. It is nine miles eaſt of London. E. Long. 0. 10. N. Lat. 51. 30.

WORCESTER, in Latin *Wigornia*, the capital of a county of England of the ſame name, ſtands on the river Severn, but ſo low that it can hardly be ſeen till one is cloſe upon it. It is ſuppoſed to be the Branonium of Antoninus, the Branogenium of Ptolemy, and to have been built by the Romans to awe the Britons on the other ſide of the Severn. It was made an epiſcopal ſee about the year 680 by Sexulphus biſhop of the Mercians; but the preſent cathedral was begun by Wulſton in the year 1084. The town hath been ſeveral times burnt down; firſt, in 1041, by Hardicanute, who alſo maſſacred the citizens; ſecondly, not long after William Rufus's time; and a third time, when King Stephen beſieged and took it. Here, in latter times, Worceſter.

was fought that battle, in which Charles II. with his Scots army, was defeated by Cromwell. In a garden, near the ſouth gate of the city, where the action was hotteſt, the bones of the ſlain are often dug up. It had formerly ſtrong walls and a caſtle; but theſe have been demoliſhed long ago. It is now a large city, the ſtreets broad and well paved, and ſome of them very regular and well built, particularly Foregate-ſtreet; ſo that in general it is a very agreeable place. The cathedral is a ſtately edifice, and among other monuments in it are thoſe of King John, of Arthur, elder brother to Henry VIII. and of the counteſs of Saliſbury, who gave occaſion to the inſtitution of the order of the Garter. There are ſeven or eight hoſpitals in and about the city; of which that built and endowed by Robert Berkley of Spetchley, Eſq. is a very noble one. There is a ſchool founded by Henry VIII. three other ſchools, and ſix charity-ſchools. The guildhall and the workhouſe are ſtately ſtructures. The churches, St Nicholas and All-Saints, have been lately rebuilt, and are very handſome edifices. The city carries on a great trade; for which it is chiefly indebted to its ſituation upon the Severn. A prodigious number of people are employed in and about it in the manufacture of broad-cloth and gloves. The Welch inhabit a part of it, and ſpeak their own language. Its market is well ſupplied with proviſions, corn, and cattle, and its quay is much frequented by ſhips. By a charter from James I. it is governed by a mayor, ſix aldermen, who are juſtices of the peace, and choſen out of 24 capital citizens; a ſheriff, the city being a county of itſelf; a common council, conſiſting of 48 other citizens, out of which two chamberlains are yearly choſen; a recorder, town-clerk, two coroners, a ſword-bearer, 13 conſtables, and four ſerjeants at mace. Of the biſhops of this ſee, there have been, it is ſaid, one pope, four ſaints, ſeven lord high-chancellors, 11 archbiſhops, two lord treaſurers, one chancellor to the queen, one lord preſident of Wales, and one vice-preſident. The city at preſent gives title of earl and marquis to the duke of Beaufort. W. Long. 1. 55. N. Lat. 52. 10.

WORCESTER, *Edward Somerſet, Marquis of,* was a diſtinguiſhed political character in the time of Charles I. by whom he was created earl of Glamorgan, while heir-apparent to the marquis of Worceſter. This nobleman flouriſhed chiefly in the reign of Charles I. and ſeems to have been a moſt zealous adherent to the cauſe of that unfortunate monarch, on whoſe account it is ſaid that he and his father waſted an immenſe ſum. Of this the king was ſo ſenſible, that he granted to the earl a moſt extraordinary patent, the chief powers of which were, to make him generaliſſimo of three armies, and admiral with nomination of his officers; to enable him to raiſe money by ſelling his majeſty's woods, wardſhips, cuſtoms, and prerogatives; and to create by blank patents, to be filled up at Glamorgan's pleaſure, from the rank of marquis to baronet. If any thing, ſays Lord Orford, could juſtify the delegation of ſuch authority, beſides his majeſty having loſt all authority, when he conferred it, it was the promiſe with which the king concluded of beſtowing the princeſs Elizabeth on Glamorgan's ſon. This patent was given up by the marquis to the houſe of peers after the reſtoration. He died not long after that era, in 1667, after he had publiſhed what Lord Orford calls the following amazing piece of folly.

Worceſter.

"A century of the names and ſcantlings of ſuch inventions, as at preſent I can call to mind to have tried and perfected, which (my former notes being loſt) I have, at the inſtance of a powerful friend, endeavoured now in the year 1655, to ſet theſe down in ſuch a way as may ſufficiently inſtruct me to put any of them in practice."

Some of the inventions referred to in this work are the following. A ſhip-deſtroying engine, a coach-ſtopping engine, a balance water-work, a bucket fountain, an ebbing and flowing caſtle clock, a tinder-box piſtol, a pocket ladder, a moſt admirable way to raiſe weights, a ſtupendous water-work. For the laſt contrivance the marquis procured an act of parliament in 1663, for the ſole benefit ariſing from it, one-tenth of it being appropriated to Charles II. and his ſucceſſors.

In a manuſcript addition to a copy of the Century of Inventions, the ſtupendous or water-commanding engine is deſcribed as boundleſs for height or quantity, requiring no external, or even additional help or force to be ſet or continued in motion, but what intrinſically is afforded from its own operation, nor yet the twentieth part thereof, and the engine conſiſteth of the following particulars. 1. A perfect counterpoiſe for what quantity ſoever of water. 2. A perfect countervail for what height ſoever it is to be brought unto. 3. A primum mobile, commanding both height and quantity, regulator-wiſe. 4. A vicegerent or countervail, ſupplying the place, and performing the full force of man, wind, beaſt, or mill. 5. A helm or ſtern, with bit and reins, wherewith any child may guide, order, and controul the whole operation. 6. A particular magazine for water, according to the intended quantity or height of water. 7. A place for the original fountain, or even river to run into, and naturally of its own accord incorporate itſelf with the riſing water, and at the very bottom of the ſame aqueduct, though never ſo big or high.

Various and very oppoſite opinions have been held with regard to the title of this nobleman to be conſidered as a mechanical genius. Lord Orford has pronounced his work an amazing piece of folly; and Mr Hume, ſpeaking of his political conduct, ſays, "that the king judged aright of this nobleman's character, appears from his Century of Arts, or Scantling of Inventions, which is a ridiculous compound of lies, chimeras, and impoſſibilities, and ſhows what might be expected from ſuch a man." *Hiſt. of England.* It may be fairly preſumed from the quotations now made, that neither Lord Orford nor Mr Hume was qualified to judge of the marquis's work, otherwiſe a more temperate or a more modified opinion would have been given. By others, the author of the inventions has been regarded as one of the greateſt mechanical geniuſes, and is to be conſidered as the inventor of the ſteam-engine, which he denominates a ſtupendous water-work. There ſeems to be no reaſon to ſuppoſe that any ſteam-engine was erected by the marquis himſelf; but it is ſaid that Captain Savary, after reading the marquis's books, tried many experiments upon the power and force of ſteam, and at laſt fell upon a method of applying it to raiſe water; and having bought up and deſtroyed all the marquis's books that could be got, claimed the honour of the invention to himſelf, and obtained a patent for it.

The marquis of Worceſter is ſometimes confounded with John Tiptoft, earl of Worceſter, a very accompliſhed literary character, who lived in the times of Henry VI. and Edward IV. Being attached to Edward, he abſconded during the ſhort reſtoration of Henry, and being taken concealed in a tree in Waybridge foreſt in Huntingdonſhire, he was brought to London, accuſed of cruelty in his adminiſtration of Ireland, and condemned and beheaded at the Tower in the year 1470. This nobleman tranſlated Cicero de Amicitia, ſome parts of Cæſar's Commentaries, and was the author of ſeveral other works.

WORCESTERSHIRE, a county of England, bounded by Warwickſhire on the eaſt, by Glouceſterſhire on the ſouth, by the counties of Hereford and Salop on the weſt, and on the north by Staffordſhire. According to Templeman, it is 36 miles in length, 28 in breadth, and about 130 in circumference, within which it contains ſeven hundreds, and a part of two others, 11 market towns, of which three are boroughs, one city, namely *Worceſter*, 152 pariſhes, about 540,000 acres, and 139,518 inhabitants.

This being an inland county, well cultivated, and free from lakes, marſhes, or ſtagnant waters, the air is very ſweet and wholeſome all over it. The ſoil in general is very rich, producing corn, fruit, eſpecially pears, of which they make a great deal of perry; hops and paſture. The hills are covered with ſheep, and the meadows with cattle. Hence they have wool, cloth, ſtuffs, butter, and cheeſe in abundance. They are alſo well ſupplied with fuel, either wood or coal, and ſalt from their brine pits and ſalt ſprings. Of the laſt they have not only enough for themſelves, but export large quantities by the Severn; which noble river, to the great convenience and emolument of the inhabitants, runs from north to ſouth through the very middle of the country, enriching the ſoil, and yielding it plenty of fiſh, and an eaſy expeditious conveyance of goods to and from it. The other rivers by which it is watered are the Stour, Avon, Teme, &c. It ſends nine members to parliament, viz. two for the county, two for the city of Worceſter, two for Droitwich, two for Eveſham, and one for Bewdley; and lies in the dioceſe of Worceſter, and Oxford circuit.

WORD, in language, an articulate ſound deſigned to repreſent ſome idea or notion. See GRAMMAR and LANGUAGE. See alſo LOGIC, Part I. chap. i.

WORD, or *Watch-word*, in military affairs, is ſome peculiar word or ſentence, by which the ſoldiers know and diſtinguiſh one another in the night, &c. and by which ſpies and deſigning perſons are diſcovered. It is uſed alſo to prevent ſurpriſes. The word is given out in an army every night to the lieutenant or major-general of the day, who gives it to the majors of the brigades, and they to the adjutants; who give it firſt to the field-officers, and afterwards to a ſerjeant of each company, who carry it to the ſubalterns. In garriſons it is given after the gate is ſhut to the town-major, who gives it to the adjutants, and they to the ſerjeants.

WORDS of Command. See EXERCISE and MANUAL.

Signals by the Drum, made uſe of in exerciſing of the Army, inſtead of the WORD *of Command, viz.*

Signals by the drum.	*Operations.*
A ſhort roll,	To caution.
A flam,	To perform any diſtinct thing.
To arms,	To form the line or battalion.
The march,	To advance, except when intended for a ſalute.
The quick march,	To advance quick.
The point of war,	To march and charge.
The retreat,	To retreat.
Drum ceaſing,	To halt.
Two ſhort rolls,	To perform the flank firing.
The dragoon march,	To open the battalion.
The grenadier march,	To form the column.
The troop,	To double diviſions.
The long roll,	To form the ſquare.
The grenadier march,	To reduce the ſquare to the column.
The preparative,	To make ready and fire.
The general,	To ceaſe firing.
Two long rolls,	To bring or lodge the colours.

WORK, in the manege. To work a horſe, is to exerciſe him at pace, trot, or gallop, and ride him at the manege. To work a horſe upon volts, or head and haunches in or between two heels, is to paſſage him, or make him go ſidewiſe upon parallel lines.

To WORK, in ſea language, is to direct the movements of a ſhip, by adapting the ſails to the force and direction of the wind. See SEAMANSHIP.

WORK, Carpenters, Clock, Crown, Field, Fire, Fret, Groteſque, Horn, Moſaic. See the ſeveral articles, together with FORTIFICATION and PYROTECHNY.

WORK-Houſe, a place where indigent, vagrant, and idle people, are ſet to work, and ſupplied with food and clothing.

Work-houſes are of two kinds, or at leaſt are employed for two different purpoſes. Some are uſed as priſons for vagrants or ſturdy beggars, who are there confined and compelled to labour for the benefit of the ſociety which maintains them; whilſt others, ſometimes called *poor-houſes*, are charitable aſylums for ſuch indigent perſons as through age or infirmity are unable to ſupport themſelves by their own labour. The former kind of work-houſe, when under proper management, may be made to ſerve the beſt of purpoſes; of the latter we are acquainted with none which entirely commands our approbation.

To make confinement in a work-houſe operate to the correction of vagrants and diſorderly perſons (and if it produce not this effect it can hardly be conſidered as a beneficial inſtitution), the priſoners ſhould be ſhut up in ſeparate cells, and compelled to labour for their own ſubſiſtence. A crew of thieves and vagabonds aſſociating with each other is a hell upon earth, in which every individual is hardened in his crimes by the countenance and converſation of his companions; and wretches who, when at liberty, chooſe to beg or ſteal rather than to earn a comfortable livelihood by honeſt induſtry, will ſubmit to any puniſhment which a humane overſeer can inflict rather than work for the benefit of others. No puniſhment indeed will compel a vagrant to labour. He may aſſume the appearance of it, but he will make no progreſs; and the pretext of ſickneſs or weakneſs is ever at hand for an excuſe. Hence it is that thieves and ſtrumpets are too often diſmiſſed from work-houſes and bridewells ten times more the children of the devil than when they entered them.

To remedy theſe evils, we can think of no better method than to confine each priſoner in a cell by himſelf, and to furniſh him daily with ſuch an allowance of bread and water as may preſerve him from *immediate* death; for the only compulſion to make ſuch men work ſeriouſly is the fear of want, and the only way to reform them is to leave them to their own meditations on the conſequences of their paſt conduct. There are ſurely very few perſons, if any, whoſe averſion from labour would not be conquered by the pinchings of hunger and the certain proſpect of periſhing by famine; and it is to be hoped that there are not many ſo totally diveſted of every latent principle of virtue as not to be brought by ſuch ſolitude to a due ſenſe of their former wickedneſs. Should one or two, however, be occaſionally found ſo very obdurate as to ſuffer themſelves to periſh rather than work, their deaths would prove a ſalutary beacon to others, and their blood would be on their own heads; for we have the expreſs command of St Paul himſelf, that "if any will not work, neither ſhould he eat."

No doubt it would be proper that the meditations of vagabonds confined in a work-houſe ſhould be directed by the private admonitions of a pious and intelligent clergyman; but it is not every clergyman who is qualified to diſcharge ſuch a duty. If he be actuated by a zeal not according to knowledge, or if he have not with equal care ſtudied human nature and the word of God, his admonitions will be more likely to provoke the profane ridicule of his auditor, and harden him in his wickedneſs, than to excite in his breaſt ſuch ſorrow for his ſins as ſhall "bring forth fruits meet for repentance." To render the inſtruction of thieves and vagrants of any uſe, it muſt be accurately adapted to the caſe of each individual; and however excellent it may be in itſelf, it will not be liſtened to unleſs offered at ſeaſons of uncommon ſeriouſneſs, which the inſtructor ſhould therefore carefully obſerve.

That ſuch wholeſome ſeverity as this would often reform the inhabitants of work-houſes, appears extremely probable from the effects of a ſimilar treatment of common proſtitutes mentioned by Lord Kames in his Sketches of the Hiſtory of Man: "A number of thoſe wretches were in Edinburgh confined in a houſe of correction, on a daily allowance of threepence, of which part was embezzled by the ſervants of the houſe. Pinching hunger did not reform their manners; for being abſolutely idle, they encouraged each other in vice, waiting impatiently for the hour of deliverance. Mr Stirling the ſuperintendant, with the conſent of the magiſtrates, removed them to a clean houſe; and, inſtead of money, appointed for each a pound of oatmeal daily, with ſalt, water, and fire for cooking. Relieved now from diſtreſs, they longed for comfort. What would they not give for milk or ale? Work (ſays he) will procure you plenty. To ſome who offered to ſpin, he gave flax and wheels, engaging to pay them half the price of their yarn, retaining the other half for the materials furniſhed. The ſpinners earned about ninepence weekly; a comfortable addition to what they had before. The reſt undertook to ſpin, one after another; and before the end of the firſt quarter they were all of them intent upon work. It was a branch of his plan to ſet free ſuch as merited that favour; and ſome of them appeared to be ſo thoroughly reformed as to be in no danger of a relapſe."

Work-houſes erected as charitable aſylums appear to us, in every view that we can take of them, as inſtitutions which can ſerve no good purpoſe. Economy is the great motive which inclines people to this mode of providing for the poor. There is comparatively but a very ſmall number of mankind in any country ſo aged and infirm as not to be able to contribute, in ſome degree, to their ſubſiſtence by their own labour; and in ſuch houſes it is thought that proper work may be provided for them, ſo that the public ſhall have nothing to give in charity but what the poor are abſolutely unable to procure for themſelves. It is imagined likewiſe, that numbers collected at a common table, can be maintained at leſs expence than in ſeparate houſes; and foot ſoldiers are given for an example, who could not live on their pay if they did not meſs together. But the caſes are not parallel. "Soldiers having the management of their pay, can club for a bit of meat; but as the inhabitants of a poor-houſe are maintained by the public, the ſame quantity of proviſions muſt be allotted to each. The conſequence is what might be expected: the bulk of them reſerve part of their victuals for purchaſing ale or ſpirits. It is vain to expect work from them: poor wretches void of ſhame will never work ſeriouſly, where the profit accrues to the public, not to themſelves. Hunger is the only effectual means for compelling ſuch perſons to work *."

The poor, therefore, ſhould be ſupported in their own houſes; and to ſupport them properly, the firſt thing to be done is, to eſtimate what each can earn by his own labour; for as far only as that falls ſhort of maintenance, is there room for charity. In repairing thoſe evils which ſociety did not or could not prevent, it ought to be careful not to counteract the wiſe purpoſes of nature, nor to do more than to give the poor a fair chance to work for themſelves. The preſent diſtreſs muſt be relieved, the ſick and the aged provided for; but the children muſt be inſtructed; and labour, not alms, offered to thoſe who have ſome ability to work, however ſmall that ability may be. They will be as induſtrious as poſſible, becauſe they work for themſelves; and a weekly ſum of charity under their own management will turn to better account than in a poor-houſe under the direction of mercenaries. Not a penny of it will be laid out on fermented liquors, unleſs perhaps as a medicine in ſickneſs. Nor does ſuch low fair call for pity to thoſe who can afford no better. Ale makes no part of the maintenance of thoſe who, in many parts of Scotland, live by the ſweat of their brows; and yet the perſon who ſhould baniſh ale from a charity work-houſe, would be exclaimed againſt as hard-hearted, and even void of humanity.

That ſuch a mode of ſupporting the poor in their own houſes is practicable, will hardly admit of a diſpute; for it has been actually put in practice in the city of Hamburgh ever ſince the year 1788. At that period ſuch revenues as had till then been expended in alms by the ſeveral church-wardens, and thoſe of which the adminiſtration had been connected with the work-houſe, were united under one adminiſtration with ſuch ſums as were collected from private benevolence. The city was divided into ſixty diſtricts, containing each an

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* Kames's Sketches.

equal number of poor; and over theſe 180 overſeers were appointed. Actual relief was the firſt object; but at the very moment that this proviſion was ſecured, meaſures were taken to prevent any man from receiving a ſhilling which he could have been able to earn for himſelf. By theſe methods, which our limits will not permit us to ſtate, the overſeers were able to make a calculation tolerably exact of what each pauper wanted for bare ſubſiſtence, in addition to the fruits of his own labour. A flax-yarn-ſpinning manufacture was eſtabliſhed, in which the yarn is paid for, not by its weight, but by its meaſure. The clean flax is ſold to the poor at a low price, and a certain meaſure of yarn again bought from them at 30 per cent. above the uſual price; ſo that the overſeers are ſure that all the yarn ſpun by the poor will be brought into their office. Every pauper brings with him a book in which the quantity delivered is carefully noted down, which furniſhes the overſeers with a continual average of the ſtate of induſtry among their poor.

As ſoon as this inſtitution was eſtabliſhed, the overſeers went through their diſtricts, and aſked, in all ſuch manſions as could be ſuppoſed to harbour want, if the inhabitants ſtood in need of ſupport? The queſtion to all ſuch poor as wiſhed for relief, and were able to ſpin, was, Whether they did earn by their work 1s. 6d. a-week? for experience had taught the inhabitants of Hamburgh, that many poor live upon that ſum; and they knew enough of their poor to ſuppoſe, that 1s. 6d. avowed earning was equal to ſomething more. If the anſwer was affirmative, the pauper ſtood not in need of weekly aſſiſtance. If it was negative, work was given him, which, by being paid 30 per cent. above its value, afforded him 1s. 6d. a-week eaſily, if he was even an indifferent hand. The far more frequent caſes were partial inability by age, or weakneſs, or want of ſkill. For poor of the latter deſcription a ſchool was opened, and in three months time the buſineſs was eaſily learnt. During that time, the pauper got firſt 2s. a-week, and every week afterwards 2d. leſs, till in the twelfth week he got nothing at all but his earnings, and was diſmiſſed, with a wheel and a pound of flax gratis.

The quantity of work which diſabled poor were capable of doing in a week was eaſily and accurately aſcertained by a week's trial in the ſpinning-ſchool. The reſult was produced weekly before appointed members of the committee, and the ſum which the poor could earn was noted down in their ſmall books. The overſeer was directed to pay them weekly what their earnings fell ſhort of 1s. 6d. in every ſuch week, when it appeared from their books that they had earned to the known extent of their abilities. From that moment applications became leſs frequent; and the committee had an infallible ſtandard for diſtinguiſhing real want: for whenever the pauper, if in health (if not, he was peculiarly provided for), had not earned what he could, then he had either been lazy, or had found more lucrative work; in either caſe, he was not entitled to a relief for that week, whatever he might be for the following.

This mode of providing for the poor, which attracted the notice and obtained the eulogium of the miniſter and the Britiſh houſe of commons, has for ſix years been in Hamburgh attended with the happieſt conſequences. In the ſtreets of that city a beggar is rarely to be ſeen, whilſt thoſe who ſtand in need of the charitable contributions of the rich, are much more comfortably, as well as at much leſs expence, maintained at home, with their children about them, than they could be in work-houſes, under the management of mercenary overſeers. For a fuller account of this judicious inſtitution, we muſt refer the readers to Voght's Account of the Management of the Poor in Hamburgh, ſince the year 1788, in a Letter to ſome Friends of the Poor in Great Britain.

WORLD, the aſſemblage of parts which compoſe the globe of the earth. See GEOGRAPHY and ASTRONOMY.

WORM, in *Gunnery*, a ſcrew of iron, to be fixed on the end of a rammer, to pull out the wad of a firelock, carabine, or piſtol, being the ſame with the wad-hook, only the one is more proper for ſmall arms, and the other for cannon.

WORM, in *Chemiſtry*, is a long winding pipe, placed in a tub of water, to cool and condenſe the vapours in the diſtillation of ſpirits.

Blind-WORM, or *Slow-WORM*. See ANGUIS, ERPETOLOGY *Index*.

Earth-WORM. See LUMBRICUS, HELMINTHOLOGY *Index*.

Glow-WORM. See LAMPYRIS, ENTOMOLOGY *Index*.

Silk-WORM. See SILK, N° 5.

WORMS, VERMES. See HELMINTHOLOGY and CONCHOLOGY.

WORMS, in the human body. See MEDICINE, N° 407.

WORMS, in horſes. } See FARRIERY.
WORMS, in dogs. }

WORMS for bait. See FISHING.

WORMS, an ancient, large, and famous city of Germany, in the palatinate of the Rhine, with a biſhop's ſee, whoſe biſhop is a ſovereign and prince of the empire. It is a free and imperial city, and the inhabitants are Proteſtants. In the war of 1689 it was taken by the French, who almoſt reduced it to aſhes.—The biſhop afterwards built a new palace in it; and it is famous for a diet held here in 1521, at which Luther aſſiſted in perſon. The Proteſtants have lately built a handſome church, where Luther is repreſented as appearing at the diet. It is noted for the excellent wine that grows in the neighbourhood, which they call *our Lady's milk*. In the campaign of 1743, King Geo. II. took up his quarters in this city, and lodged at the biſhop's palace after the battle of Dettingen. It is ſeated on the weſtern bank of the Rhine, 14 miles north-weſt of Heidelberg, 20 ſouth-eaſt of Mentz, and 32 ſouth-weſt of Franckfort. E. Long. 8. 29. N. Lat. 49. 32.

WORMING OF DOGS. All dogs have certain ſtrings under their tongues, by moſt called *a worm;* this muſt be taken out when they are about two months old, with the help of a ſharp knife to ſlit it, and a ſhoemaker's awl to raiſe it up; you muſt be careful to take all out, or elſe your pains is to little purpoſe; for till then he will be hardly ever fat and right, in regard the worm or ſtring will grow foul and troubleſome, and hinder his reſt and eating. This cruel operation is generally recommended as a preventive of madneſs in dogs, or at leaſt as diſabling them, if mad, from biting in that condition.

In this operation, of which the vulgar account is given,

ven above, which we have juſtly denominated a cruel one, it is not a ſtring that is removed, but the duct by which the ſaliva is conveyed from the gland in which it is ſecreted to the mouth for the purpoſe of mixing with the food and promoting its deglutition and digeſtion. Now this operation by no means prevents the animal from biting, nor can it, in our opinion, obſtruct the flow of the ſaliva by which the dreadful diſeaſe hydrophobia is communicated.

WORMIUS, Olaus, a learned Daniſh phyſician, born in 1588 at Arhuſen in Jutland. After beginning his ſtudies at home, he ſtudied at ſeveral foreign univerſities, and travelled to various parts of Europe for improvement. He returned to his native country in 1613, and was made profeſſor of the belles lettres in the univerſity of Copenhagen. In 1615, he was tranſlated to the chair of the Greek profeſſor; and in 1624 to the profeſſorſhip of phyſic, which he held to his death. Theſe occupations did not hinder him from practiſing in his profeſſion, and from being the faſhionable phyſician: the king and court of Denmark always employed him; and Chriſtian IV. as a recompenſe for his ſervices, conferred on him a canonry of Lunden. He publiſhed ſome pieces on ſubjects relating to his profeſſion, ſeveral works in defence of Ariſtotle's philoſophy, and ſeveral concerning the antiquities of Denmark and Norway; for which latter he is principally regarded, as they are very learned, and contain many curious particulars. He died in 1654.

WORMWOOD. See Artemisia, Botany *Index.*

WORSHIP of God (*cultus Dei*), amounts to the ſame with what we otherwiſe call *religion.* This worſhip conſiſts in paying a due reſpect, veneration, and homage to the Deity, under a certain expectation of reward. And this internal reſpect, &c. is to be ſhown and teſtified by external acts; as prayers, ſacrifices, thankſgivings, &c.

The Quietiſts, and ſome other myſtic divines, ſet aſide not only all uſe of external worſhip, but even the conſideration of rewards and puniſhments. Yet even the heathens had a notion that God did not require us to ſerve him for nought: "Dii quamobrem colendi ſint (ſays Cicero), non intelligo, nullo nec accepto ab illis nec ſperato bono."

The ſchool-divines divide worſhip into divers kinds, viz. *latria*, that rendered to God; and *idololatria*, that rendered to idols or images. To which the Romaniſts add, *dulia*, that rendered to ſaints; and *hyperdulia*, that to the Virgin. Some theological writers have obſerved, that the Greek word, *προσκυνεω*, *to worſhip*, is not deſcriptive only of the honour which is appropriated to God, but is indifferently uſed to ſignify the honour and reſpect which are paid to ſuperiors of all kinds in heaven or on earth. Accordingly, they have diſtinguiſhed between civil and religious worſhip.

That it is the duty of man to worſhip his Maker, has been ſufficiently proved under other articles (ſee Prayer; and Theology, N° 40—45.). It is not indeed eaſily to be conceived how any one who has tolerably juſt notions of the attributes and providence of God, can poſſibly neglect the duty of *private* worſhip; and though we have admitted in the laſt of the two articles referred to, that *public* worſhip does not ſeem to be enjoined in that ſyſtem which is called the religion of *nature*, yet it is moſt expreſsly commanded by the religion of Christ, and will be regularly performed by every one who reflects on its great utility.

As the illiterate vulgar cannot form to themſelves correct notions of the divine providence and attributes, it is obvious, that without the inſtitution of public worſhip, they would never think of worſhipping God at all, unleſs perhaps occaſionally, when under the preſſure of ſome ſevere calamity; but occaſional worſhip, the offſpring of compulſion, could have little of the reſigned ſpirit of true devotion. Ignorant, however, as the loweſt of the vulgar are, and neceſſarily muſt be, it cannot be denied, that in moſt Chriſtian countries, perhaps in all, they are more accurately acquainted with the firſt principles of religion, and the laws of morality, than even the leaders of barbarous nations. This ſuperiority is doubtleſs owing in ſome meaſure to their acceſs to the Sacred Scriptures, but much more, we are perſuaded, to the inſtruction which they receive in the aſſemblies which they frequent for public worſhip. If this be admitted, public worſhip may be eaſily proved to be the duty of every individual of the community: For were thoſe, who may be ſuppoſed to ſtand in no need either of the contagion of ſociety to kindle their own devotion, or of the preaching of a clergyman to inſtruct them in the doctrines and precepts of the goſpel, to "forſake, on theſe accounts, the aſſembling themſelves together, as the manner of ſome is," religious aſſemblies and public worſhip would very quickly fall into univerſal diſuſe. Man is an animal prone to imitation; and every order in ſociety is ambitious of treading in the footſteps of the order immediately above it. Were the wiſe and the good, therefore, permitted to abſent themſelves from the aſſemblies inſtituted for the public worſhip of the Creator and Redeemer of the world, others would quickly follow their example; impelled to it not only by this univerſal propenſity, but by the additional motive of wiſhing to appear both to the world and to themſelves as wiſe and as good as their privileged neighbours. The conſequence is obvious: one man would ſtay from church with the ſerious intention perhaps of employing the Lord's day in private devotion and religious ſtudy; another, following his example, would abſent himſelf upon the ſame pretence, but would in reality waſte the day in dozing indolence or in ſecret ſenſuality. For theſe and other reaſons which might be eaſily aſſigned, no ſincere Chriſtian will think himſelf at liberty to diſpute a practice enjoined by the inſpired preachers of his religion, coeval with the inſtitution, and retained by every ſect into which it has ſince been unhappily divided.

As Chriſtian worſhip conſiſts of prayers and praiſes, it has been a matter of ſome debate whether it is moſt properly performed by preconcerted forms or liturgies, or by extemporaneous addreſſes to the Almighty. Both theſe modes have their advantages and diſadvantages; and by the ſacred writers neither of them is preſcribed in oppoſition to the other.

The advantages of a liturgy are, that it prevents abſurd, extravagant, or impious addreſſes to God, which the folly or enthuſiaſm of individuals muſt always be in danger of producing; it gives the congregation an opportunity of *joining* in the prayers which are put up for them, which they cannot poſſibly do in a ſeries of extemporaneous petitions, ſince before they can aſſent to any

any one of theſe and make it their own, their attention is neceſſarily called away to that which ſucceeds it; and it relieves the clergyman from the labour of compoſition, which ſeems incompatible with that fervour which conſtitutes the ſpirit of devotion.

The diſadvantages of a fixed liturgy, which are the recommendations of extemporary prayer, are principally two. The forms compoſed in one age muſt, by the unavoidable change of language, circumſtances, and opinions, become in ſome degree unfit for another; and the perpetual repetition of the ſame form of words is very apt to produce inattentive laſſitude in the congregation. Would the clergy of the church of England take that liberty which is allowed them in the bidding prayer before ſermon, perhaps the ſervice of that church would unite in itſelf all the advantages both of liturgic and extemporary worſhip. We have only to add on this ſubject, that public prayers, whether precompoſed or not, ought to be compendious; that they ought to expreſs juſt conceptions of the Divine attributes; recite ſuch wants as the congregation are likely to feel, and no other; that they ought to contain as few controverted propoſitions as poſſible; and that, if it can be done without offence, the pompous ſtyle of *the ſtate* ſhould be laid aſide in our prayers for the king and all that are in authority; becauſe in every act which carries the mind to God, human greatneſs muſt be annihilated.

WORT, the infuſion of malt, of which beer is made. See BREWING. The uſes of this infuſion in common affairs are well known. By Dr M'Bride it has lately been found to have a ſtrong antiſeptic virtue, and to be uſeful in preventing the ſcurvy and other diſeaſes to which ſailors are liable; this was confirmed by Captain Cook in his voyages. See *Means of Preſerving the Health of* SEAMEN.

It is of great importance to the manufacturer to be able to aſcertain with facility and preciſion the real ſtrength of worts, or the quantity of ſaccharine matter contained in the infuſion. This is accompliſhed by determining the ſpecific gravity by means of inſtruments, which, from the purpoſe to which they are applied, have obtained the name of *ſaccharometers*. But as theſe inſtruments, from the very nature of the material of which they are conſtructed, are liable to conſiderable change, the reſults which they afford cannot always be depended on. With the view of obviating theſe inconveniencies, the patent areometrical beads have been invented by Mrs Lovi of Edinburgh. We have already noticed theſe beads, on account of their accuracy, ſimplicity, and facility of application for aſcertaining the ſpecific gravity, or the real ſtrength and value, of ſpirituous liquors. See vol. xix. p. 599.; and we now recommend them with greater confidence, from having had opportunities of knowing that they are capable of a more extended application, as in the manufacture of acids, and ſalts of different kinds; to aſcertain the ſtrength of acids, or that of ſaline ſolutions in bleaching; to determine the ſtrength of liquids employed in the different proceſſes of calico printing and dyeing, and not only for the purpoſe of examining the ſtrength of the acids employed, but alſo particularly to aſcertain the denſity or ſpecific gravity of the colouring matters which are uſed in theſe arts, ſo that the ſame degree of ſhade required may be always obtained. It has been ſuggeſted, that theſe beads might be conveniently employed in determining the ſtrength of mineral waters, which, it is well known, vary conſiderably at different ſeaſons of the year.

As the patent beads are conſtructed on the ſame principle from 800, the ſpecific gravity of alcohol, to 2000, which is double the ſpecific gravity of water; and as they are divided into different ſeries, each of which includes a range of ſpecific gravities applicable to the particular fluids, the denſity or ſtrength of which is required, we have no heſitation in aſſerting that they will be found extremely convenient and uſeful to all manufacturers and dealers, who wiſh to aſcertain with accuracy the real ſtrength and value of liquids.

It has been objected to the uſe of theſe beads, that they require a longer time than other inſtruments in uſing them. The ſame objection has been made to the introduction of other new inſtruments, the application of which frequent uſe has afterwards rendered familiar and eaſy. We have had opportunities of knowing that this objection is completely obviated, by thoſe who have been accuſtomed to uſe the beads. They find that they can determine the ſpecific gravity of a liquid by means of the beads with the ſame facility, and in as ſhort a time, as with any other inſtrument.

WOTTON, SIR HENRY, an eminent writer, was the ſon of Thomas Wotton, Eſq. and was born in 1568. He ſtudied for ſome time at New-college, Oxford, whence he removed to Queen's-college, where he made a great progreſs in logic and philoſophy; wrote a tragedy for the uſe of that college, called *Tancredo;* and afterwards received the degree of maſter of arts. After this, leaving the univerſity, he travelled into France, Germany, and Italy; and having ſpent about nine years abroad, he returned to England, and became ſecretary to Robert earl of Eſſex, with whom he continued till that earl was apprehended for high-treaſon. He then retired to Florence, where he became known to the the grand duke of Tuſcany, who ſent him privately with letters to James VI. king of Scotland, under the name of *Octavio Baldi*, to inform that king of a deſign againſt his life. Some months after he went back to Florence; but King James coming to the poſſeſſion of the crown of England, Mr Wotton returned home, was knighted by his majeſty, and ſent ambaſſador to the republic of Venice; and afterwards was employed in many other embaſſies to that and other courts; but the only reward he obtained for theſe ſervices was his having the provoſtſhip of Eton conferred upon him about the year 1623, which he kept till his death, which happened in 1639. After his deceaſe ſome of his manuſcripts and printed tracts were publiſhed together in a volume, intitled, *Reliquiæ Wottonianæ*.

WOTTON, *Dr William*, a learned divine and writer, was the ſon of Mr Henry Wotton, B. D. rector of Wrentham, in Suffolk, where he was born in 1666. He was educated by his father, a gentleman well ſkilled in the learned languages; under whom he made ſuch amazing proficiency, that at five years of age it is ſaid he could render ſeveral chapters in the goſpels out of Latin and Greek, and many pſalms in Hebrew, into his mother tongue. When he was very young, he remembered the whole of almoſt every diſcourſe he had heard, and often ſurpriſed a preacher by repeating his ſermon to him. He was admitted into Catharine-hall in Cambridge ſome months before he was ten years old; when the progreſs he made in learning in that univerſity engaged

gaged Dr Duport, then maſter of Magdalen college, and dean of Peterborough, to write an elegant copy of Latin verſes in his praiſe. In 1679 he took the degree of bachelor of arts when he was but twelve years and five months old; and the winter following he was invited to London by Dr Gilbert Burnet, then preacher at the Rolls, who introduced him to moſt of the learned men in that city, and particularly to Dr William Lloyd, biſhop of St Aſaph; to whom he recommended himſelf by repeating to him one of his ſermons, as Dr Burnet had engaged he ſhould. In 1691 he commenced bachelor of divinity. The ſame year Biſhop Lloyd gave him the ſinecure of Llandrillo, in Denbighſhire. He was afterwards made chaplain to the earl of Nottingham, then ſecretary of ſtate, who preſented him to the rectory of Middleton Keynes, in Bucks, and to whom he dedicated his Reflections upon Ancient and Modern Learning. In 1705, Biſhop Burnet gave him a prebend in the church of Saliſbury; and in 1707, Archbiſhop Teniſon preſented him with the degree of doctor of divinity: but in 1714, the difficulties he laboured under with reſpect to his private fortune, obliged him to retire into South Wales, where he was treated with great kindneſs and humanity by the gentlemen of that country; and wrote there the "Memoirs of the Cathedral Churches of St David's and Landaff," and his "Miſcellaneous Diſcourſes relating to the Traditions and Uſages of the Scribes and Phariſees;" which were afterwards printed. He died in 1726. This great man was remarkable for his humanity and friendlineſs of temper; the narrowneſs of a party ſpirit never broke in upon any of his friendſhips; and his time and abilities were at the ſervice of any perſon who was making advances in real learning. He wrote, beſides the above works, 1. A Hiſtory of Rome. 2. A Defence of his Reflections upon Ancient and Modern Learning. 3. A Diſcourſe concerning the Languages of Babel. 4. Advice to a young Student, with a Method of Study for the firſt four Years; and other learned pieces.

WOUNDS, in *Surgery*, have been divided into *ſimple*, *contuſed* or *lacerated*, and *gun-ſhot*.

Of Simple Wounds.—The firſt thing to be conſidered in the inſpection of a wound is, whether it be likely to prove mortal or not. This knowledge can only be had from anatomy, by which the ſurgeon will be able to determine what parts are injured; and, from the offices which theſe parts are calculated to perform, whether the human frame can ſubſiſt under ſuch injuries. It is not, however, eaſy for the moſt expert anatomiſt always to prognoſticate the event with certainty; but this rule he ought always to lay down to himſelf, to draw the moſt favourable prognoſis the caſe will bear, or even more than the rules of his art will allow. This is particularly incumbent on him in ſea-engagements, where the ſentence of death is executed as ſoon as pronounced, and the miſerable patient is thrown alive into the ſea, upon the ſurgeon's declaring his wound to be mortal. There are, beſides, many inſtances on record, where wounds have healed, which the moſt ſkilful ſurgeons have deemed mortal. The following wounds may be reckoned mortal.

1
Wounds which are neceſſarily mortal.

1. Thoſe which penetrate the cavities of the heart, and all thoſe wounds of the viſcera where the large blood-veſſels are opened; becauſe their ſituation will not admit of proper applications to reſtrain the flux of blood.

2. Thoſe which entirely cut off the paſſage of the nervous influence through the body. Such are wounds of the brain, cerebellum, medulla oblongata, and ſpinal marrow. Wounds likewiſe of the ſmall blood-veſſels within the brain are attended with great danger, from the effuſed fluids preſſing upon the brain. Nor is there leſs danger where the nerves which tend to the heart are wounded, or entirely divided; for, after this, it is impoſſible for the heart to continue its motion.

3. All wounds which entirely deprive the animal of the faculty of breathing.

4. Thoſe wounds which interrupt the courſe of the chyle to the heart; ſuch are wounds of the receptacle of the chyle, thoracic duct, and larger lacteals, &c.

5. There are other wounds which prove fatal if neglected and left to nature: ſuch are wounds of the larger external blood-veſſels, which might be remedied by ligature. Wounds of ſuch parts generally prove fatal; and though a few inſtances may have occurred where people have recovered after them, yet they are always to be conſidered as extremely dangerous. Portions of the brain have been deſtroyed, and wounds have been made into it, and the patients have lived. It is poſſible, too, that the thoracic duct might be wounded and the patient live; Mr A. Cooper having ſhown, in a very ingenious paper in the Medical Records and Reſearches, that it may become obſtructed, and the chyle conveyed into the ſyſtem by anaſtomoſing lymphatics.

2
Symptoms of wounds in different parts of the body.

In examining wounds, the next conſideration is, whether the parts injured are ſuch as may be ſuppoſed to induce dangerous ſymptoms, either immediately or at ſome period during the courſe of the cure. In order to proceed with any degree of certainty, it is neceſſary to be well acquainted with thoſe ſymptoms which attend injuries of the different parts of the body. If the ſkin and part of the cellular ſubſtance are only divided, the firſt effects are an effuſion of blood; the lips of the wound retract, become tumefied, red and inflamed, leaving a gap of conſiderable wideneſs according to the length and deepneſs of the wound. If a very conſiderable portion of ſkin and cellular ſubſtance is divided, a ſlight fever ſeizes the patient; the effuſion of blood in the mean time ſtops, and the wound is partly filled up with a cake of coagulated blood. Below this cake, the ſmall veſſels pour forth a clear liquor, which in a ſhort time is converted into pus (ſee the articles Pus and Mucus). Below this pus granulations of new fleſh ariſe, the cake of coagulated blood looſens, a new ſkin covers the place where the wound was, and the whole is healed up; and there only remains a mark, called a *cicatrix* or *ſcar*, ſhowing where the injury had been received.

3
Of wounds of the ſkin and cellular ſubſtance.

4
Of the muſcles.

All wounds are accompanied with a conſiderable degree of pain, eſpecially when the inflammation comes on, though the diviſion reaches no farther than the ſkin and cellular ſubſtance. If the muſcular fibres are divided, the pain is much greater, becauſe the ſound part of the muſcle is ſtretched by the contraction of the divided part and the action of the antagoniſt muſcle, which it is now leſs fitted to bear. The wound alſo gaps much more than where the cellular ſubſtance is

alone

alone divided, inſomuch that, if left to itſelf, the ſkin will cover the muſcular fibres, without any intervention of cellular ſubſtance; and not only a very unſightly cicatrix remains, but the uſe of the muſcle is in ſome meaſure loſt.—If the muſcle happens to be totally divided, its fibres retract to a very conſiderable diſtance; and unleſs proper methods be taken to bring them into contact, the uſe of it is ever afterwards loſt.

5
Of the arteries.

If by a wound any conſiderable artery happens to be divided, the blood flows out with great velocity, and by ſtarts; the patient ſoon becomes faint with loſs of blood; nor does the hæmorrhagy ſtop until he faints away altogether; and if as much *vis vitæ* ſtill remains as is ſufficient to renew the operations of life, he recovers after ſome time, and the wound heals up as uſual. The part of the artery which is below the wound in the mean time becomes uſeleſs, ſo that all the inferior part of the limb would be deprived of blood, were it not that the ſmall branches ſent off from the artery above the wounded place become enlarged, and capable of carrying on the circulation. Nature alſo, after a wonderful manner, often produces new veſſels from the ſuperior extremity of the divided artery, by which the circulation is carried on as formerly. The conſequences of ſuch a profuſe hæmorrhagy may be, however, very dangerous to the patient, by inducing extreme debility, or an univerſal dropſy. This great hæmorrhagy happens eſpecially where the artery is partially divided; becauſe then the veſſel cannot contract in ſuch a manner as to cloſe the orifice: however, if the wound is but ſmall, the blood gets into the cellular ſubſtance, ſwelling up the member to an extreme degree, forming what is called a *diffuſed aneuriſm*. Thus the hæmorrhagy ſoon ſtops externally, but great miſchief is apt to flow from the confinement of the extravaſated blood, from bringing on exterior ſuppuration among the muſcles and bones; and thus not only the uſe of the limb is entirely loſt, but the patient is brought into great danger of his life.

6
Of the ligaments, nerves, and tendons.

Wounds of the ligaments, nerves, and tendons, are likewiſe attended with bad conſequences. When a nerve is entirely divided, the pain is but trifling, though the conſequences are often dangerous. If the nerve is large, all the parts to which it is diſtributed below the wound immediately loſe the power of motion and ſenſation. This, however, takes place only when all or the greateſt part of the nerves belonging to a particular part are divided. If the ſpinal marrow, for inſtance, be divided near the head, the parts below ſoon loſe their ſenſation irrecoverably; or if the bundle of nerves paſſing out of the axilla be divided or tied, ſenſation in the greateſt part of the arm below will be loſt. But though a nerve ſhould be divided, and a temporary palſy be produced, it may reunite, and perform its former functions. If a nerve be wounded only, inſtead of being divided, the worſt ſymptoms frequently enſue.

7
Of the thorax, and the viſcera which it contains.

Wounds which penetrate the cavities of the thorax are always exceedingly dangerous, becauſe there is ſcarce a poſſibility of all the viſcera eſcaping unhurt. A wound is known to have penetrated the cavity of the thorax principally by the diſcharge of air from it at each inſpiration, by an extreme difficulty of breathing, and by coughing up blood. Such wounds, however, are not always mortal; the lungs have frequently been wounded, and yet the patient has recovered.—Wounds of the diaphragm are almoſt always mortal, either by inducing fatal convulſions immediately, or by the aſcent of the ſtomach, which the preſſure of the abdominal muſcles forces up through the wound into the cavity of the thorax; of this Van Swieten gives ſeveral inſtances.—Even though the wound do not penetrate into the cavity of the thorax, the very worſt ſymptoms may follow. For if the wound deſcends deeply among the external muſcles, and its orifice lies higher, the extravaſated blood will be therein collected, ſtagnate, and form various ſinuſes; which after having eroded the pleura, may at length paſs into the cavity of the thorax. The matter having once found a vent into this cavity, will be continually augmenting from the diſcharge of the ſinuous ulcer, and the lungs will at laſt ſuffer by the ſurrounding matter. If, in caſes of wounds in the thorax, the ribs or ſternum happen to become carious, the cure will be extremely tedious and difficult. Galen relates the caſe of a lad who received a blow upon his ſternum in the field of exerciſe: it was firſt neglected, and afterwards badly healed; but, four months afterwards, matter appeared at the place which had received the blow. A phyſician made an inciſion into the part, and it was ſoon after cicatrized: but in a ſhort time a new collection made its appearance, and upon a ſecond inciſion the wound refuſed to heal. Galen found the ſternum carious; and having cut off the diſeaſed part, the pericardium itſelf was obſerved to be corroded, ſo that the heart could be ſeen quite naked; notwithſtanding which, the wound was cured in no very long time.

There is ſometimes difficulty in determining whether the wound has really penetrated into the thorax or into the abdomen; for the former deſcends much farther towards the ſides than at the middle. But as the lungs are almoſt always wounded when the cavity of the thorax is penetrated, the ſymptoms ariſing from thence can ſcarcely be miſtaken.—Another ſymptom which frequently, though not always, attends wounds of the thorax, is an emphyſema. This is occaſioned by the air eſcaping from the wounded lungs, and inſinuating itſelf into the cellular ſubſtance; which being pervious to it over the whole body, the tumor paſſes from one part to another, till at laſt every part is inflated to a ſurpriſing degree. An inſtance is given in the Memoirs of the Royal Academy, of a tumour of this kind, which on the thorax was eleven inches thick, on the abdomen nine, on the neck ſix, and on the reſt of the body four; the eyes were in a great meaſure thruſt out of their orbits by the inflation of the cellular ſubſtance; and the patient died the fifth day. This was occaſioned by a ſtab with a ſword.

8
Of the abdomen and its viſcera.

Wounds of the abdomen are not leſs dangerous than thoſe of the thorax, on account of the importance of the viſcera which it contains. When the wound does not penetrate the cavity, there is ſome danger of a hernia being formed by the protruſion of the peritonæum through the weakened integuments, and the danger is greater the larger the wound is. Thoſe wounds which run obliquely betwixt the interſtices of the muſcles often produce ſinuous ulcers of a bad kind. For as there is a large quantity of fat interpoſed everywhere betwixt the muſcles of the abdomen, if a wound happens to run between them, the matter there collected, not meeting with free egreſs through the mouth of the wound, often makes its way in a ſurpriſing manner through the cellular ſubſtance, and forms deep ſinuoſities between the muſcles; in which caſe the cure is always difficult, and ſometimes impoſſible.

If a large wound penetrate the cavity of the abdomen, ſome of the viſcera will certainly be protruded through it; or if the wound is but ſmall, and cloſed up with fat ſo that none of the inteſtines can be protruded, we may know that the cavity of the abdomen is pierced, and probably ſome of the viſcera wounded, by the acute pain and fever, paleneſs, anxiety, faintings, hiccough, cold ſweats, and weakened pulſe, all of which accompany injuries of the internal parts. The miſchiefs which attend wounds of this kind proceed not only from the injury done to the viſcera themſelves, but from the extravaſation of blood and the diſcharge of the contents of the inteſtines into the cavity of the abdomen; which, being of a very putreſcent nature, ſoon bring on the moſt violent diſorders. Hence wounds of the abdominal viſcera are very often mortal. This, however, is not always the caſe, for the ſmall inteſtines have been totally divided, and yet the patient has recovered. Wounds both of the ſmall and large inteſtines have healed ſpontaneouſly, even when they were of ſuch magnitude that the contents of the inteſtine were freely diſcharged through the wound into the abdomen, and after part of the inteſtine itſelf has been protruded through the wound of the integuments.

When the meſentery is injured, the danger is extreme, on account of its numerous veſſels and nerves. Wounds of the liver, ſpleen, and pancreas, are alſo exceedingly dangerous, although there are ſome inſtances of the ſpleen being cut out of living animals without any conſiderable injury.

From the preceding account of the ſymptoms attending wounds in the different parts of the body, the ſurgeon may be enabled to judge in ſome meaſure of the event; though it muſt always be remembered, that wounds, even thoſe which ſeemed at firſt to be of the ſlighteſt nature, have, contrary to all expectation, proved mortal, chiefly by inducing convulſions, or a locked jaw; ſo that no certain prognoſtic can be drawn on ſight of recent wounds. We ſhall now, however, proceed to conſider their treatment.

9
Treatment of wounds.

For the cure of wounds, it has been already obſerved, that the ancients imagined balſams, the juice of herbs, &c. to be ſpecifics. In after-ages, and in countries where balſams are not eaſily to be procured, ſalves were ſubſtituted in their place; and even at this day there are many who reckon a ſalve or ointment eſſentially neceſſary for healing the ſlighteſt cut. It is certain, however, that the cure of wounds cannot be effected, nay, not even forwarded in the leaſt, by ointments, unleſs in particular caſes. That power which the human frame has of repairing the injuries done to itſelf, which by phyſicians is called *vis medicatrix naturæ*, is the ſole agent in curing external injuries; and without this the moſt celebrated balſams would prove ineffectual. When a wound has been made with a ſharp inſtrument, and is not extenſive, if it be immediately cleaned and all the extravaſated blood ſucked (A) out or waſhed way, it will almoſt always heal by *adheſion*. When a wound does not heal by this proceſs, there are three ſtages to be obſerved in its cure; the firſt, called ſuppuration, which takes place when the ends of the wounded veſſels contract themſelves, and pour out the liquor which is converted into pus. As ſoon as this appears, the ſecond, or granulating ſtage, in which the fleſh begins to grow up, takes place; and as this proceeds, the edges of the wound acquire a fine bluiſh or pearl colour, which is that of the new ſkin beginning to cover the wound as far as the granulations have filled it up. This proceſs continues, and the ſkin advances from all ſides towards the centre, which is called the *cicatrizing* of the wound. For the promoting of each of theſe proceſſes, ſeveral ointments were formerly much in vogue. But it is now found, that no ointment whatever is capable of promoting them; and that it is only neceſſary to keep the wound clean, and to prevent the air from having acceſs to it. This, indeed, nature takes care to do, by covering the wound with a cake of coagulated blood; but if a wound of any conſiderable magnitude ſhould be left entirely to nature, the pus would form below the cruſt of coagulated blood in ſuch quantity, that it would moſt probably corrupt, and the wound degenerate into a corroding ulcer. It is neceſſary, therefore, to cleanſe the wound frequently; for this purpoſe it will be proper to apply a little ointment ſpread on ſoft ſcraped lint. And, in a healthy body, the wound will heal without further trouble. As to the ointment employed, it is almoſt indifferent what it be, provided it has no acrid or ſtimulating ingredient in its compoſition; hogs lard or the ſimple ointment of the Pharmacopeia will anſwer perfectly.

But though, in general, wounds thus eaſily admit of a cure, there are ſeveral circumſtances which require a different treatment, even in ſimple diviſions of the fleſhy parts, when neither the membranous nor tendinous parts are injured. Theſe are, 1. Where the wound is large, and gapes very much, ſo that, if allowed to heal in the natural way, the patient might be greatly disfigured by the ſcar. It is proper to bring the lips of the wound near to each other, and to join them either by adheſive plaſter or by ſuture, according as the wound is ſuperficial, or deep. 2. When foreign bodies are lodged in the wound, as when a cut is given by glaſs, &c. it is neceſſary to extract them, before the wound is dreſſed; for it will never heal until they are diſcharged. When theſe bodies are ſituated in ſuch a manner as not to be capable of being extracted without lacerating the adjacent parts, which would occaſion violent pain and other bad ſymptoms, it is neceſſary to enlarge the wound, ſo that theſe offending bodies may be eaſily removed. This treatment, however, is chiefly neceſſary in gunſhot wounds, of which we ſhall afterwards ſpeak. 3. When the wound is made in ſuch a manner that it runs for ſome length below the ſkin, and the bottom is much lower than the orifice, the matter collected from all parts of the wound will be lodged in the bottom of it, where, corrupting by the heat, it will degenerate into a fiſtulous ulcer. To prevent this, we muſt

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(A) See an account of the method of ſucking wounds, in Mr John Bell's *Diſcourſes on Wounds*, Part i. diſcourſe v. p. 215.

muſt uſe compreſſes, applied ſo that the bottom of the wound may ſuffer a more conſiderable preſſure than the upper part of it. Thus the matter formed at the bottom will be gradually forced upwards, and that formed at the upper part will be incapable of deſcending by its weight; the divided parts, in the mean time, eaſily uniting when brought cloſe together. Indeed, the power which nature has of uniting different parts of the human body is very ſurpriſing; for, according to authors of credit, even if a piece of fleſh be totally cut out, and applied in a ſhort time afterwards to the place from whence it was cut, it will unite. That a part cut out of a living body does not entirely loſe its vital power for ſome time, is evident from the modern practice of tranſplanting teeth; and from an experiment of Mr John Hunter's, where he put the teſticle of a cock into the belly of a living hen, and the teſticle adhered to the liver, and became connected to it by means of blood-veſſels *. We have therefore the greateſt reaſon to hope, that the divided parts of the human body, when cloſely applied to each other, will cohere without leaving any ſinus or cavity between them. However, if this method ſhould fail, and matter be collected in the depending part of the wound, it will be neceſſary to make an opening in that part in order to let it out; after which the wound may be cured in the common way. 4. During the courſe of the cure, it ſometimes happens that the wound, inſtead of filling up with granulations of a florid colour, ſhoots up into a glaſſy-like ſubſtance which riſes above the level of the ſurrounding ſkin, while, at the ſame time, inſtead of laudable pus, a thin ill-coloured and fetid ichor is diſcharged. In this caſe the lips of the wound loſe their beautiful pearl colour, and become callous and white, nor does the cicatrizing of the wound at all advance. When this happens in a healthy patient, it generally proceeds from ſome improper management, eſpecially the making uſe of too many emollient and relaxing medicines, an immoderate uſe of balſams and ointments. Frequently nothing more is requiſite for taking down this fungus than dreſſing with dry lint; at other times deſiccative powders, ſuch as calamine, tutty, calcined alum, &c. will be neceſſary; and ſometimes red precipitate mercury muſt be uſed. This laſt, however, is apt to give great pain, if ſprinkled in its dry ſtate upon the wound; it is therefore moſt proper to grind it with ſome yellow baſilicon ointment, which makes a much more gentle, though at the ſame time an efficacious eſcharotic. Touching the overgrown parts with blue vitriol is alſo found very effectual.

10
Of the regimen of patients in wounds.

Hitherto we have conſidered the wounded patient as otherwiſe in a ſtate of perfect health; but it muſt be obſerved, that a large wound is capable of diſordering the ſyſtem to a great degree. If the patient is ſtrong and vigorous, and the pain and inflammation of the wound great, conſiderable degree of fever may ariſe, which it will be neceſſary to check by bleeding, low diet, and other parts of the antiphlogiſtic regimen, at the ſame time the inflamed lips of the wound and parts adjacent are to be treated with emollient fomentations or cataplaſms till the pain and ſwelling abate. On the other hand, it may happen, when the patient is of a weak and lax habit, that the *vis vitæ* may not be ſufficient to excite ſuch an inflammation in the wound as is abſolutely neceſſary for its cure. In this caſe, the edges of the wound look pale and ſoft; the wound itſelf ichorous and bloody, without any ſigns of granulations; or if any granulations ſhoot up, they are of the fungous glaſſy kind above mentioned. To ſuch wounds all external applications are vain; it is neceſſary to ſtrengthen the patient by proper internal remedies, among which the bark has a principal place, until the wound begins to alter its appearance. In ſuch perſons, too, there is ſome danger of a hectic fever by the abſorption of matter; and this will take place during the courſe of the cure, even when the appearances have been at firſt as favourable as could be wiſhed. This happens generally when the wound is large, and a great quantity of matter formed: for by this diſcharge the patient is weakened; ſo that the pus is no ſooner formed, than it is reconveyed into the body by the abſorbent veſſels, and immediately affects the patient with feveriſh heat. When this takes place, the beſt remedy is to exhibit the bark copiouſly, at the ſame time to ſupport the patient by proper cordials and nouriſhing diet. Indeed, in general, it will be found, that, in the caſe of wounds of any conſiderable magnitude, a more full and nouriſhing regimen is required than the patient, even in health, has been accuſtomed to; for the diſcharge of pus alone, where the quantity is conſiderable, proves very debilitating. And it is conſtantly found, that the cure of ſuch ſores goes on much more eaſily when the patient is kept in his uſual habit of body, than when his ſyſtem is much emaciated by a very low allowance; and, for the ſame reaſon, purgatives, taken more freely than what is neceſſary to keep the bowels open, and whatever elſe tends to weaken the conſtitution, are improper in the cure of wounds.

11
Of hæmorrhagies from wounds.

Hæmorrhagies very frequently happen in wounds, either from a diviſion of a large artery, or of a number of ſmall ones. In this caſe, the firſt ſtep to be taken by the ſurgeon is to effect a temporary ſtoppage of the blood by means of compreſſion, and he is then to tie up all the larger veſſels according to the methods uſually directed.

When the principal arteries of a wound have been tied, and a little blood continues to be diſcharged, which appears to come from ſundry ſmall veſſels only, an experienced ſurgeon is induced to think, that the compreſſion of the bandages will in all probability effect a total ſtoppage of the hæmorrhagy. In a general oozing from the whole ſurface of a ſore, and when no particular veſſel can be diſtinguiſhed, there is a neceſſity for truſting to the bandage or compreſſion; but whenever an artery can be diſcovered, of whatever ſize it may be, it ought to be ſecured by a ligature. But it frequently happens, that conſiderable quantities of blood are diſcharged, not from any particular veſſel, but from all the ſmall arteries over the ſurface of the wound; and in wounds of great extent, particularly after the extirpation of cancerous breaſts, and in other operations where extenſive ſores are left, this ſpecies of hæmorrhagy often proves very troubleſome by being exceedingly difficult to ſuppreſs.

In conſtitutions perfectly healthy, on the occurrence of wounds even of the moſt extenſive nature, as ſoon as the larger arteries are ſecured, all the ſmall veſſels which have been divided are diminiſhed, not only in their diameters, but alſo in their length; in conſequence of which, they recede conſiderably within the ſurface of the

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* See *Blood*, N° 19.

the ſurrounding parts. This cauſe of itſelf would probably, in the greateſt number of inſtances, prove ſufficient for reſtraining all loſs of blood from the ſmaller arteries. Another very powerful agent however is provided by nature for producing the ſame effect. From the extremities of the divided veſſels which at firſt diſcharged red blood, there now, in their contracted ſtate, oozes out a more thin, though viſcid fluid, containing a great proportion of the coagulable parts of the blood; and this being equally diſtributed over the ſurface of the wound, by its agglutinating powers has a very conſiderable influence in reſtraining all ſuch hæmorrhagies.

When a tedious oozing occurs in a patient young and vigorous, and where the tone of the muſcular fibres is evidently great, the moſt effectual means of putting a ſtop to the diſcharge is to relax the vaſcular ſyſtem, either by opening a vein in ſome other part, or, what gives ſtill more immediate relief, by untying the ligature on one of the principal arteries of the part, ſo as to allow it to bleed freely: thoſe violent ſpaſmodic twitchings too, ſo frequent after operations on any of the extremities, when they do not depend on a nerve being included in the ligature with the artery, are in this manner more effectually relieved than by any other means.

By the ſame means the patient, from being in a febrile heat and much confuſed, ſoon becomes very tranquil: the violent pulſation of the heart and larger arteries abates, and the blood not being propelled with ſuch impetuoſity into the ſmaller veſſels of the part, they are left at more liberty to retract.

The patient ought to be kept exceedingly cool; wine and other cordials ſhould be rigidly avoided; cold water, acidulated either with the mineral or vegetable acids, ought to be the only drink; motion of every kind, particularly of the part affected, ſhould be guarded againſt; and the lip of the wound being drawn together by adheſive plaſter, and gently covered with ſoft charpie, it ought to be tied up with a bandage ſo applied as to produce a moderate degree of preſſure on the extremities of the divided parts.

As ſoon as a ſufficient quantity of blood has been diſcharged, the wound dreſſed, and the patient laid to reſt, a doſe of opium proportioned to the violence of the ſymptoms ought to be immediately exhibited. It ought to be remarked, however, that in all ſuch circumſtances, much larger doſes of this medicine are neceſſary than in ordinary caſes requiring the uſe of opiates. Small doſes, inſtead of anſwering any good purpoſe, ſeem frequently rather to aggravate the various ſymptoms; ſo that whenever they are had recourſe to in ſuch caſes, they ought always to be given in quantities ſufficient for the intended effect.

But hæmorrhagies of this nature happen much more frequently in relaxed enfeebled habits, where the ſolids have loſt part of their natural firmneſs, and the fluids have acquired a morbid tenuity. In this caſe a moderate uſe of generous wine ought to be immediately preſcribed; for nothing tends ſo much, in ſuch circumſtances, to reſtrain hæmorrhagies, as a well directed uſe of proper cordials. By tending to invigorate and brace the ſolids, they enable the arterial ſyſtem to give a due reſiſtance to the contained fluids; and have alſo a conſiderable influence in reſtoring to the fluids that viſcidity of texture, of which in all ſuch inſtances we ſuppoſe them to be deprived.

A nouriſhing diet alſo becomes proper; the patient ought to be kept cool; and the mineral acids, from their known utility in every ſpecies of hæmorrhagy, ought alſo to be preſcribed. Reſt of body is here alſo proper; and opiates, when indicated either by pain or ſpaſmodic affections of the muſcles, ought never to be omitted.

Together with theſe remedies adapted to the general ſyſtem, particular dreſſings, appropriated to the ſtate of the parts to which they are to be applied, have been found very beneficial. In healthy conſtitutions, ſoon after the diſcharge of blood is over, the parts are covered with a viſcid coagulable effuſion from the mouths of the now retracted arteries; but in conſtitutions of an oppoſite nature, where the ſolids are much relaxed, the blood in general is found in ſuch an attenuated ſtate as to afford no ſecretion of this nature.

To ſupply as much as poſſible the deficiency of this natural balſam, different artificial applications have been invented. Duſting the part with ſtarch or wheat-flour has ſometimes been found of uſe, and gum arabic in fine powder has been known to anſwer when theſe failed.

Applications of this kind, indeed, have been uſed with ſucceſs in all ſuch hæmorrhagies, with whatever habit of body they happen to be connected; but they have always proved more particularly ſerviceable in relaxed conſtitutions, attended with an attenuated ſtate of the blood and an enfeebled muſcular ſyſtem. Alcohol, or any other ardent ſpirits, impregnated with as great a quantity as they can diſſolve of myrrh, or any other of the heating viſcid gums, may be here uſed with freedom, though in conſtitutions of an oppoſite nature they ought never to be employed. The *balſamum traumaticum* of the ſhops, a remedy of this nature, has long been famous for its influence in ſuch caſes: but that indiſcriminate uſe of this and ſimilar applications which has long prevailed with ſome practitioners, has undoubtedly done much harm; for as they are all poſſeſſed of very ſtimulating powers, they of courſe tend to aggravate every ſymptom in wounds connected with a tenſe ſtate of fibres, or much pain, eſpecially when ſpaſmodic muſcular affections prevail.

By a due perſeverance in one or other of the plans here pointed out, it will ſeldom happen that hæmorrhagies are not at laſt put a ſtop to: but when the contrary does occur, when, notwithſtanding the uſe of the remedies recommended, a diſcharge of blood ſtill continues; in addition to the means already adviſed, an equal moderate preſſure ought to be applied over the whole ſurface of the ſore, to be continued as long as the neceſſity of the caſe ſeems to indicate.

In finiſhing the dreſſings of ſuch wounds, after the adheſive plaſter and compreſſes have been applied, a bandage properly adapted to the part ought to be employed, and in ſuch a manner as to produce as equal a degree of preſſure over the ſurface of the wound as poſſible. But it now and then happens that no bandage can be applied ſo as to produce the deſired effect; and in ſuch caſes the hand of an aſſiſtant is the only reſource; which being firmly preſſed over the dreſſings, will commonly ſucceed when no other means is found to have much influence.

12
Symptoms which ſometimes ſucceed blood-letting.

Wounds of the nerves, tendons, and ligaments, are attended with much more violent ſymptoms than thoſe where even conſiderable arteries are divided, and they frequently reſiſt every method of cure propoſed by the moſt ſkilful practitioners. In the ſimple proceſs of blood-letting, it frequently happens that the tendinous expanſion called the *aponeuroſis* of the biceps muſcle is wounded, or even the tendon of that muſcle itſelf is punctured, by the point of the lancet; or ſometimes a nerve which happens to lie in the neighbourhood is partially divided. Any one of theſe wounds, though they are the ſmalleſt we can well ſuppoſe to be given, are frequently very dangerous and difficult of cure. It ſometimes immediately happens on the introduction of the lancet, that the patient complains of a moſt exquiſite degree of pain; and when this occurs, we may reſt aſſured that either a tendon or a nerve has been wounded. On ſome occaſions, by proper management, ſuch as evacuating a conſiderable quantity of blood at the orifice newly made, by keeping the part at perfect reſt, and preſerving the patient in as cool a ſtate as poſſible, the pain at firſt complained of will gradually abate, and at laſt go off entirely without any bad conſequence. At other times, however, this pain which occurs inſtantaneouſly on the introduction of the lancet, inſtead of abating, begins ſoon to increaſe; a fullneſs, or ſmall degree of ſwelling, takes place in the parts contiguous to the wound; the lips of the ſore become ſomewhat hard and inflamed; and, in the courſe of about 24 hours from the operation, a thin watery ſerum begins to be diſcharged at the orifice.

If, by the means employed, relief is not ſoon obtained, theſe ſymptoms generally continue in nearly the ſame ſtate for two or perhaps three days longer. At this time the violent pain which at firſt took place becomes ſtill more diſtreſſing; but inſtead of being ſharp and acute as before, it is now attended with the ſenſation of a burning heat, which goes on to increaſe, and proves, during the whole courſe of the ailment, a ſource of conſtant diſtreſs to the patient. The fullneſs and hardneſs in the lips of the wound begin to increaſe, and the ſwelling in the neighbouring parts gradually extends over the whole members. The parts at laſt become exceedingly tenſe and hard; an eryſipelatous inflammatory colour frequently appears over the whole member; the pulſe by this time is generally very hard and quick; the pain is now intenſe, the patient exceedingly reſtleſs; twitchings of the tendons occur to a greater or leſs degree; on ſome occaſions, a locked jaw and other convulſive affections ſupervene; and all theſe ſymptoms continuing to increaſe, it moſt frequently happens that the torture under which the patient has been groaning is at laſt terminated by death.

13
Opinions about the cauſes of theſe ſymptoms.

Different opinions have prevailed reſpecting the cauſe of theſe ſymptoms. By ſome they have been imputed to wounds of the tendons. By others the tendons are ſuppoſed to be ſo entirely deſtitute of ſenſibility, as to be quite incapable of producing ſo much diſtreſs; ſo that wounds of the nerves they conſider, on all ſuch occaſions, as the true cauſe of the various ſymptoms we have mentioned.

One or other of theſe ideas continued to be the only ſource for explaining the various phenomena found to occur in this malady, till a different opinion was ſuggeſted by the late ingenious Mr John Hunter of London. Mr Hunter ſuppoſed, that all the dreadful ſymptoms found now and then to be induced by the operation of blood-letting, might be more readily accounted for from an inflamed ſtate of the internal ſurface of the vein, than from any other cauſe. Such a ſtate of the vein he has often traced in horſes that have died of ſuch ſymptoms from veneſection, and the ſame appearances have ſometimes occurred alſo in the human body. And on other occaſions, inflammation having in this manner been once excited, has been known to terminate in ſuppuration; and the matter thus produced being in the courſe of circulation carried to the heart, Mr Hunter ſuppoſes that in ſuch caſes death may have been induced by that cauſe alone.

14
Mr John Hunter's opinion

There can be no reaſon to doubt the fact held forth by Mr Hunter, that in ſuch inſtances the vein in which the orifice has been made, has frequently after death been found greatly inflamed: but however ingenious his arguments may be for concluding that the ſtate of the vein is the original cauſe of all the bad ſymptoms enumerated, and although we muſt allow that ſuch an inflammatory affection of a vein muſt have a conſiderable influence in aggravating the various ſymptoms previouſly induced by other cauſes; yet we may very fairly conclude, that it could not probably in any one inſtance be able to account with ſatisfaction for their firſt production.

In many caſes the patient, at the very inſtant of the operation, feels a very unuſual degree of pain. In ſome caſes, the violence of the pain is almoſt unſupportable. Now this we can never ſuppoſe to have been produced by the mere puncture of a vein; for although the coats of veins are not perhaps entirely deſtitute of feeling, yet we know well that they are not endowed with ſuch a degree of ſenſibility as to render it probable that ſuch intenſe pain could ever be induced by their being punctured in any way whatever. This inflamed ſtate of the veins therefore, as detected by Mr Hunter after death, muſt be conſidered rather as being produced by, than as being productive of, ſuch affections; and that ſuch ailments ſhould frequently produce an inflammation of the contiguous veins, is a very probable conjecture. In the courſe of 48 hours from the operation, when the febrile ſymptoms are juſt commencing, ſuch a degree of hardneſs and evident inflammation is induced over all the parts contiguous to the orifice, that it would be ſurpriſing indeed if the vein, which is thus perhaps entirely ſurrounded with parts highly inflamed, ſhould eſcape altogether. We ſhall therefore proceed upon the ſuppoſition of this inflamed ſtate of the veins being a conſequence rather than the cauſe of ſuch ailments; and of courſe we now revert to one or other of the opinions long ago adopted on this ſubject, that all the train of bad ſymptoms found on ſome occaſions to ſucceed veneſection, proceeds either from the wound of a nerve or of a tendon.

15
not juſt.

16
Really owing to the partial wounding of a nerve or tendon.

That a partial wound of a nerve will now and then produce very diſtreſſing ſymptoms, no practitioner will deny: but it has been attempted to be ſhown, that tendons are almoſt totally deſtitute of ſenſibility; and it has therefore been ſuppoſed, that their being wounded can never account for the various ſymptoms known to occur in ſuch caſes. There is great reaſon however to think, that in different inſtances the ſame train of ſymptoms have been induced by different cauſes; that in one inſtance a wounded nerve, and in others pricks of the tendons, have given riſe to them, as we have already ſuppoſed.

17 Method of obviating theſe ſymptoms, and curing the wound.

In order to prevent as much as poſſible the conſequent inflammation and other ſymptoms which uſually enſue, a conſiderable quantity of blood ſhould be immediately diſcharged at the orifice juſt made: the limb, for ſeveral days at leaſt, ought to be kept in a ſtate of perfect reſt, care being at the ſame time taken to keep the muſcles of the part in as relaxed a ſtate as poſſible: the patient ſhould be alſo kept cool, on a low diet; and, if neceſſary, gentle laxatives ought to be adminiſtered.

When, notwithſtanding theſe means, the ſymptoms, inſtead of diminiſhing, rather become more violent; if the lips of the orifice turn hard and more inflamed, if the pain become more conſiderable, and eſpecially if the ſwelling begin to ſpread, other remedies come to be indicated. In this ſtate of the complaint, topical blood-letting, by means of leeches applied as near as poſſible to the lips of the wound, frequently affords much relief; and when the pulſe is full and quick, it even becomes neceſſary to evacuate large quantities of blood by opening a vein in ſome other part.

The external applications uſually employed in this ſtate of the complaint are warm emollient fomentations and poultices. In ſimilar affections of other parts no remedies with which we are acquainted would probably be found more ſucceſsful; but in the complaint now under conſideration, all ſuch applications, inſtead of being productive of any advantage, rather do harm. The heat of the part is here one of the moſt diſtreſſing ſymptoms; and warm emollient applications rather tend to augment this ſource of uneaſineſs. The lips of the wound alſo are rendered ſtill more hard, ſwelled, and of courſe more painful; and the ſwelling of the contiguous parts is increaſed. The beſt external remedies are cooling aſtringents, eſpecially the ſaturnine applications. The parts chiefly affected being alternately covered over with cloths wet with a ſolution of ſaccharum ſaturni, and pledgets ſpread with Goulard's cerate, are kept more cool and eaſy than by any other remedy hitherto uſed. The febrile ſymptoms which occur muſt at the ſame time be attended to, by keeping the patient cool, on a low diet, preſerving a lax ſtate of the bowels; and, if neceſſary, farther quantities of blood ought to be evacuated.

On account of the violence of the pain, which is ſometimes ſo exceſſive as to deſtroy entirely the patient's reſt, opiates ought to be freely exhibited; and when twitchings of the tendons and other convulſive ſymptoms ſupervene, medicines of this kind become ſtill more neceſſary. In order, however, to have a proper influence in this ſtate of the complaint, opiates ought to be given in very full doſes; otherwiſe, inſtead of anſwering any good purpoſe, they conſtantly tend to aggravate the different ſymptoms, not only by increaſing the heat and reſtleſſneſs, but by having an evident influence in rendering the ſyſtem more ſuſceptible than it was before of the pain and other diſtreſſing effects produced upon it by the wound.

It often happens, however, either from neglecting the wound or from improper treatment, that all theſe remedies are had recourſe to without any advantage whatever: the fever, pain, and ſwelling of the parts continue, and convulſive affections of the muſcles at laſt occur, all tending to indicate the moſt imminent danger. In this ſituation of matters, if we have not immediate recourſe to ſome effectual means, the patient will ſoon fall a victim to the diſorder; and the only remedy from which much real advantage is to be expected, is a free and extenſive diviſion of the parts in which the orifice producing all the miſchief was at firſt made. We know well, from the experience of ages, that much more pain and diſtreſs of every kind are commonly produced by the partial diviſion either of a nerve or of a tendon, than from any of theſe parts being at once cut entirely acroſs. Now the intention of the operation here recommended, is to produce a complete diviſion of the nerve or tendon we ſuppoſe to have been wounded by the point of the lancet, and which we conſider as the ſole cauſe of all the ſubſequent diſtreſs.

This operation being attended with a good deal of pain, and being put in practice for the removal of ſymptoms from which it is perhaps difficult to perſuade the patient that much danger can occur, all the remedies we have mentioned ſhould be made trial of before it is propoſed: but at the ſame time, care ought to be taken that the diſorder is not allowed to proceed too far before we have recourſe to it; for if the patient ſhould be previouſly much weakened by the feveriſh ſymptoms having continued violent for any length of time, neither this remedy nor any other with which we are acquainted would probably have much influence. As ſoon, therefore, as the courſe already preſcribed has been fairly tried, and is found to be inadequate to the effects expected from it, we ought immediately to have recourſe to a free diviſion of the parts affected.

18 Treatment of wounded or ruptured tendons.

Wherever a wounded or ruptured tendon may be ſituated, the limb ſhould be placed in ſuch a manner as will moſt readily admit of the retracted ends of the tendon being brought together; and when in this ſituation, the muſcles of the whole limb in which the injury has happened muſt be tied down with a roller, ſo as to prevent them from all kinds of exertion during the cure, endeavouring at the ſame time to keep the parts eaſy and relaxed. Thus, in a wound or rupture of the tendon of the rectus muſcle of the thigh, the patient's *leg* ſhould be kept as much as poſſible ſtretched out during the cure, while the thigh ſhould be in ſome degree bent, to relax the muſcle itſelf as far as poſſible.

In ſimilar affections of the tendo Achillis, the *knee* ſhould be kept conſtantly bent to relax the muſcles of the leg, and the foot ſhould be ſtretched out to admit of the ends of the ruptured tendon being brought into contact. A roller ſhould be applied with a firmneſs quite ſufficient for ſecuring the muſcles and tendons in this ſituation; but care muſt be taken to prevent it from impeding the circulation. With this view, ſoft fine flannel ſhould be preferred either to linen or cotton; for being more elaſtic, it more readily yields to any ſwelling with which the limb may be attacked.

The late Dr Monro was the firſt who gave any accurate directions for the treatment of rupture in the large tendons; and it is perhaps given with more preciſion, from his having himſelf experienced the effects of this misfortune in the tendo achillis.

He uſed a foot-ſock or ſlipper, made of double quilted ticking, and left open at the toe; from the heel of which a ſtrap went up above the calf of the leg. A

ſtrong

ſtrong piece of the ſame materials went round the calf, and was faſtened with a lace. On the back part of this was a buckle, through which the ſtrap of the foot-ſock was paſſed, by which the calf could be brought down, and the foot extended at pleaſure. Beſides there was a piece of tin applied to the fore part of the leg, to prevent the foot from getting into any improper poſture during ſleep. After propoſing to walk, he put on a ſhoe with a heel two inches deep; and it was not till the expiration of five months that he ventured to lay aſide the tin plate; and he continued the uſe of the high-heeled ſhoe for two years.

From this treatment a knowledge may be formed of the treatment neceſſary to be followed in the laceration of tendons of other parts of the body.

19 Wounds of the thorax.

In wounds of the thorax, even though none of the viſcera ſhould be wounded, we may yet reaſonably expect that a conſiderable quantity of blood will be extravaſated; and this, if very large, muſt be evacuated if poſſible. However, it ought to be particularly obſerved, that this extravaſated blood ſhould not be diſcharged before we are aſſured that the wounded veſſels have done bleeding. When the pulſe appears ſufficiently ſtrong and equal, the extremities warm, no hickup or convulſion, and the patient's ſtrength continues, we may then know that the internal hæmorrhagy has ceaſed, and that the means for diſcharging the blood may now be ſafely uſed. Matter, water, and blood have ſometimes vaniſhed from the cavities of the thorax, and been afterwards diſcharged by ſweat, urine, &c. Yet this but ſeldom happens; and if we were to truſt to nature alone in theſe caſes, it is certain that many would periſh from a deſtruction of the vital viſcera by the extravaſated blood, who by an artificial extraction of the ſame blood might have been ſaved.

20 Wounds of the abdomen.

Wounds of the abdomen muſt be cloſed as ſoon as poſſible, and then treated as ſimple wounds; only they ought to be dreſſed as ſeldom and expeditiouſly as poſſible. Copious bleeding and a ſpare diet, with other parts of the antiphlogiſtic regimen, are here abſolutely neceſſary.

It ſometimes happens, that, through a large wound of the abdominal integuments, the inteſtine comes out without being injured. The moſt certain method, in all ſuch caſes, is to return the protruded part as ſoon as poſſible; for although writers in general formerly recommended warm fomentations, &c. to be previouſly applied, the lateſt authors upon this ſubject conſider the moſt natural and proper fomentation to be that which is produced by the heat and moiſture of the patient's belly, and that therefore the inteſtines, if no mortification has taken place, are to be cleared from extraneous matter, and immediately returned.

When the wound of the abdomen is large, the inteſtines eaſily prolapſe, and they are as eaſily returned. But when part of an inteſtine has been forced through a narrow wound, it is much more dangerous. For the prolapſed inteſtine being diſtended by flatus, or the ingeſted aliments driven thither by the periſtaltic motion, it will become inflamed, tumefied, and incapable of being returned through the ſtricture of the wound; whence gangrene will ſoon follow. In this caſe the utmoſt care is to be taken to reduce the inteſtine to its natural ſize. When this cannot be accompliſhed by other means, ſome practitioners of great eminence have even adviſed the puncturing of the inteſtine in different places in order to diſcharge the flatus. This practice has alſo been recommended in an incarcerated hernia, but is exceedingly diſapproved of by Mr Pott and later writers; and it ſeems to be very dubious whether any good can poſſibly ariſe from it. To puncture any part that is already inflamed, muſt undoubtedly add to the inflammation; and it is very improbable that the diſcharge of flatus procured by the punctures would be at all a recompenſe for the bad conſequences produced by the increaſed inflammation. The method of Celſus is much more eligible: It is to dilate the wound ſo as to reduce the inteſtine with eaſe.

Sometimes part of the inteſtine is loſt either by ſuppuration or gangrene. In this caſe, all that can be done is to put a ſingle ſtitch through the wounded bowel, and to fix it to the external wound by paſſing the ſuture alſo through the ſides of the wound. The ends of the inteſtine may perhaps adhere; or at any rate the wound will continue to perform the office of an anus, out of which the fæces will continue to be diſcharged during life. The directions given by ſome ſurgeons about inſerting the upper end of the gut into the lower, and ſtitching them together, are perfectly impracticable; and even if they were practicable, would certainly produce new mortification, which could not but be fatal.

When the omentum appears prolapſed, the ſame general treatment is to be obſerved; only that, when it is mortified, the dead part may be ſafely extirpated.—We ſhall conclude the article of abdominal wounds with a caſe from the memoirs of the academy of ſciences for the year 1705, which ſhows that we ought not to deſpair, even though the moſt deſperate ſymptoms ſhould take place. A madman wounded himſelf in 18 different places of the abdomen. Eight of theſe penetrated the cavity, and injured the contained viſcera; he had a diarrhœa, nauſea, and vomiting, tenſion of the abdomen, with difficult reſpiration and violent fever, ſo that his life was deſpaired of. During the firſt four days he was blooded ſeven times; and during the greateſt part of the cure his diet conſiſted almoſt entirely of fleſh-broths, with the addition of ſome mild vegetables. By theſe means he was not only cured of his wounds, but reſtored to his right ſenſes. Seventeen months after, he went mad again, and threw himſelf over a precipice, by which he was inſtantly killed. On opening the body, the wounds were found to have penetrated the middle lobe of the liver, the inteſtinum jejunum, and the colon.

Such extraordinary cures are to be imputed, according to the ſatisfactory explanation of Mr J. Bell, to the abdomen being perfectly full, and conſtantly ſubjected to ſtrong preſſure between the diaphragm and abdominal muſcles; which keeps the parts contiguous to a wound cloſely applied to it, alſo in ſome meaſure prevents the diſcharge of fæces or even of blood, and gives an opportunity for a very ſpeedy adheſion between the parts.

21 Wounds of the head.

In wounds of the head, where the cellular membrane only is affected, and the aponeuroſis and pericranium are untouched, phlebotomy, lenient purges, and the uſe of the common febrifuge medicines, particularly thoſe of the neutral kind, generally remove all the threatening ſymptoms. When the inflammation is gone off, it leaves on the ſkin a yellowiſh tint and a dry ſcurf, which continue until perſpiration takes them away; and upon the removal of the diſeaſe, the wound immediately recovers a healthy aſpect, and ſoon heals without further trouble. But in the worſt kind of theſe wounds, that is, where a ſmall wound paſſes through the tela celluloſa and aponeuroſis to the pericranium, the patient will admit of more free evacuations by phlebotomy than in the former. In both, the uſe of warm fomentations is required; but an emollient cataplaſm, which is generally forbid in the eryſipelatous ſwellings, may in this latter caſe be uſed to great advantage. Where the ſymptoms are not very preſſing, nor the habit very inflammable, this method will prove ſufficient; but it ſometimes happens that the ſcalp is ſo tenſe, the pain ſo great, and the ſymptomatic fever ſo high, that by waiting for the ſlow effect of ſuch means the patient runs a riſk from the continuance of the fever; or elſe the injured aponeuroſis and pericranium become ſloughy, produce an abſceſs, and render the caſe both tedious and troubleſome. A diviſion of the wounded part, by a ſimple inciſion down to the bone, about half an inch or an inch in length, will moſt commonly remove all the bad ſymptoms; and if it be done in time, will render every thing elſe unneceſſary.

22
Wounds of the joints.

The wounds penetrating into the cavities of the joints do not ſeem at firſt alarming; yet, by expoſure to the air, the lining membrane of ſuch cavities acquires ſuch a degree of ſenſibility as to endanger life when they are large. As ſoon therefore as any extraneous body, puſhed into the joint, is removed, the admiſſion of the external air is to be guarded againſt as much as poſſible. If the wound be not too large, this may be done by pulling the ſkin over the wound of the joint; and, to prevent its retraction, rather adheſive plaſter, with proper bandaging, is to be uſed. But when inflammation has come on, repeated and copious blood-letting, together with fomentations, becomes neceſſary; and as the pain, in theſe caſes, is apt to be violent, opiates muſt be adminiſtered; but ſhould matter be formed in the cavity of the joint, free vent muſt be given to it.

Of contuſed and lacerated Wounds.—When the ſmall veſſels are ruptured by a blow with any hard inſtrument without penetrating the ſkin, at the ſame time that the ſolid fibres of the part are cruſhed, the injury is termed a *contuſion*: and when at the ſame time the ſkin is broken, it is termed a *contuſed and lacerated wound*.

23
Symptoms and effects of contuſions.

Every contuſion therefore, whether the ſkin is broken or not, may be properly reckoned a wound; where the injury is ſo ſlight that none of the contents of the ſmall veſſels are extravaſated, it ſcarcely deſerves to be mentioned. The immediate conſequence of a contuſion, therefore, is a ſwelling, by reaſon of the extravaſation juſt mentioned; and the ſkin becomes diſcoloured by the blood ſtagnating under it: but as this fluid, even though covered by the ſkin, cannot long remain in the natural ſtate, it thence happens, that the contuſed part ſoon loſes its florid red colour, and becomes blue or black; the thinner parts being in the mean time gradually taken up by the abſorbent veſſels. This at laſt happens to the blood itſelf; the blue diſappears, and is ſucceeded by a yellowiſh colour, ſhowing that the blood is now diſſolved; after which, the part recovers its former appearance, and the ruptured veſſels appear to have united as if no injury had happened.

Theſe are the ſymptoms which attend the ſlighteſt kind of contuſions; but it is evident, that where the blow is ſo violent as to rupture the blood-veſſels or cruſh ſome of the large nerves, all the bad conſequences which attend ſimple wounds of thoſe parts will enſue, and they will not be at all alleviated by the circumſtance of the ſkin remaining whole. Hence it is eaſy to ſee how a contuſion may produce ulcers of the worſt kind, gangrene, ſphacelus, carious bones, &c.; and if it happen to be on a glandular part, a ſchirrus or cancer is very frequently found to enſue. Even the viſcera themſelves, eſpecially of the abdomen, may be injured by contuſions to ſuch a degree as to produce an inflammation, gangrene, or ſchirrus, nay inſtant death, without rupturing the ſkin.

Of Gun-ſhot Wounds.—Gun-ſhot wounds can be conſidered in no other light than contuſed wounds. In thoſe made by a muſket or piſtol ball, the firſt things to be done are, to extract the ball, or any other extraneous body which may have lodged in the wounded part; and to ſtop the hemorrhagy, if there be an effuſion of blood from the rupture of ſome conſiderable artery.

24
Extraction of the ball or other foreign bodies.

It is frequently neceſſary to enlarge the wound in order to extract the ball; and if it has gone quite through (provided the ſituation of the part wounded will admit of its being done with ſafety), the wound is to be laid freely open through its whole length; by which means any extraneous body will be more readily removed, and the cure facilitated.

In order to get at the ball, or any foreign matter, the probe is to be uſed as ſparingly as poſſible: and this muſt appear evident to any one who will only conſider the nature of the ſymptoms attendant on penetrating wounds of the breaſt or belly, either from a bullet or ſharp inſtrument; the thruſting in a probe to parts under ſuch circumſtances being unavoidably a freſh ſtab on every repetition. Wherever probing is neceſſary, the finger is to be preferred as the beſt and trueſt probe, where it can be uſed.

If a ball, or any other foreign body, happen to be lodged near the orifice, or can be perceived by the finger to lie under the ſkin, though at ſome diſtance from the mouth of the wound, we ſhould cut upon it and take it out: but when it is ſunk deep, and lies abſolutely beyond the reach of the finger, it muſt appear evident, upon the leaſt reflection, that thruſting, firſt a long probe in queſt of the bullet, and then, as has been likewiſe practiſed a long pair of forceps, either with or without teeth, into a wound of that kind, though with ſome certainty to extract it, muſt either contuſe, or irritate and inflame the parts to a great degree; and conſequently do as much, or more, miſchief as the ball did at firſt in forcing its paſſage to ſuch a length. And ſhould they at the ſame time lay hold of any conſiderable artery or nerve along with the ball (which can ſcarce ever fail of being the caſe), what ſhocking conſequences would attend ſuch a proceeding! Nor would attempts of this ſort be leſs injurious, if a bullet ſhould happen to be lodged in the cavity of the belly or breaſt. Such attempts are the leſs neceſſary, becauſe a great number of inſtances have occurred, where balls have been quietly lodged in ſeveral parts of the body, till after many years they have worked themſelves a paſſage towards the ſurface, and were very eaſily extracted; and many caſes alſo where balls have been entirely left behind.

In caſe the wound be occaſioned by a muſket or piſtol

25 Dilatation of the wound.

ſtol ſhot, and of courſe be ſmall, it will be neceſſary to dilate the wound without delay, provided the nature of the part will permit of this with ſafety: for in wounds near a joint, or in very membranous or tendinous parts, the knife, as well as forceps, ſhould be put under ſome reſtraint; nor ſhould any more opening be made than what is abſolutely requiſite for the free diſcharge of the matter lodged within.

Where the wounded perſon has not ſuffered any great loſs of blood, and this is generally the caſe, it will be adviſable to open a vein immediately, and take from the arm a large quantity; and to repeat bleeding as circumſtances may require, the ſecond, and even the third day.

26 Advantage of bleeding.

Repeated bleedings in the beginning are followed by many advantages. They prevent pain and a good deal of inflammation, leſſen any feveriſh aſſaults, and ſeldom fail to obviate impoſthumations, and a long train of complicated ſymptoms which are wont otherwiſe to interrupt the cure, miſerably haraſs the poor patient, and too often endanger his life. Even where the feveriſh ſymptoms run high, and there is almoſt a certainty that matter is forming, bleeding, in ſuch a ſtate, is very frequently of great advantage.

27 Regimen.

For the firſt twelve days after the wound has been received, it will be proper to obſerve a cooling regimen, both in reſpect of the medicines that may be preſcribed, and the diet requiſite for the ſupport of the patient. It is likewiſe abſolutely neceſſary that the body be conſtantly kept open. Unleſs, therefore, nature does this office of herſelf, a ſtool ſhould be every day procured, either by emollient clyſters, or ſome gentle laxative taken at the mouth; and whenever there is much pain in the wounded parts, immediate recourſe muſt be had to opium.

28 External application.

As to external applications, whatever is of a hot ſpirituous nature is remarkably injurious on theſe occaſions, and what no wounded part can in any degree bear. The wound may be dreſſed with pledgits of any emollient ointment; the whole being covered with a common poultice, or, in ſome caſes, the preparations of lead may be uſed. An opiate ſhould now be adminiſtered; and the part affected being placed in the eaſieſt and moſt convenient poſture, the patient ſhould be laid to reſt. The formation of matter, in every contuſed wound, is an object of the firſt importance; for, till this takes place, there is often reaſon to ſuſpect that gangrene may happen. With a view to haſten ſuppuration, the warm poultices ſhould be frequently renewed, and they ſhould be continued till the tenſion and ſwelling, with which wounds of this kind are uſually attended, be removed, and till the ſore has acquired a red, healthy, granulating appearance, and then it is to be treated like a common ulcer.

Gun-ſhot wounds are commonly covered from the beginning with deep ſloughs, and various remedies are recommended for removing theſe. Every appearance, however, of this kind with which they are attended proceeds entirely from contuſion; and, excepting the injury be extenſive, the ſlough is not often perceptible, or it is ſo thin as to come away along with the matter at the firſt or ſecond dreſſing. Although emollient poultices be extremely uſeful, they ought to be no longer continued than till the effects already mentioned are produced; otherwiſe they will not only relax the parts, but alſo produce too copious a diſcharge of matter, which is ſometimes attended with great danger. A too copious flow of matter may proceed from different cauſes; but in whatever way it may have been produced, the practice to be adopted muſt be nearly the ſame. Every collection which appears muſt have a free outlet, and the limb laid in that poſture which will moſt readily admit of its running off. In ſuch circumſtances, nouriſhing diet and Peruvian bark in conſiderable quantities are highly uſeful. When the diſcharge continues copious, in ſpite of every effort to check it, detached pieces of bone or ſome extraneous matter are probably the cauſe. In ſuch a ſituation nothing will leſſen the quantity of matter till ſuch ſubſtances be removed. The wound ought therefore again to be examined, and any looſe bodies taken away. Pieces of cloth have been known to be removed by ſetons, when that method was practicable, after every other method had failed. Opium is frequently uſed in checking an exceſſive diſcharge, when it happens to be kept up by irritation.

Although no conſiderable hemorrhagy may happen on firſt receiving a gun-ſhot wound; yet after the ſloughs commonly produced upon ſuch occaſions have come off, ſome conſiderable arteries may be expoſed, and then a dangerous hemorrhagy may enſue. The hemorrhagy is often preceded by a great heat in the injured parts, and with a throbbing pulſatory pain. At this period it may frequently be prevented by plentiful blood-letting, particularly local. But if the hemorrhagy has fairly taken place, and from arteries of conſiderable ſize, nothing will reſtrain it but the proper application of ligatures. As the diſcharge in theſe caſes would often prove dangerous before the ſurgeon could be procured, the attendants ſhould be furniſhed with a tourniquet, with directions to apply it, upon the firſt appearance of blood.

29 Scarifying improper.

Till of late years the ſcarifying of gun-ſhot wounds was a practice which prevailed very univerſally among ſurgeons; and it was expected by this, that the ſloughs with which wounds are ſometimes covered would ſooner ſeparate, and that the cure would thereby be more readily performed. It is now, however, known, that this practice, inſtead of being uſeful, very generally does harm by increaſing the inflammation. It ſhould therefore be laid entirely aſide.

When a gun-ſhot wound cannot eaſily or ſafely be laid open from one end to the other, perhaps it may be proper to introduce a cord through the ſinus. This, however, ſhould not be attempted till the firſt or inflammatory ſtate of the wound is over: but when a cord cannot be properly introduced, on account of the ſituation or direction of the wound, compreſſion may prove equally uſeful here as in caſes of punctured wounds.

30 Mortification.

Mortification happening after gun-ſhot wounds, is to be treated in the ſame manner as if it had ariſen from any other cauſe, only bark is not to be promiſcuouſly uſed; as, in plethoric habits, it may prove hurtful, though in debilitated relaxed habits it will be extremely uſeful; but even in ſuch it ſhould never be given while much pain and tenſion continue.

31 Symptoms of compreſſion of the brain.

Of Wounds and Injuries of the Head producing Fractures and Depreſſions.—When the brain is compreſſed, a ſet of ſymptoms enſue, extremely dangerous, though ſometimes they do not make their appearance till after a conſiderable interval. But at whatever time they appear, they are uniformly of the ſame kind, and are in general as follows: drowſineſs, giddineſs, and ſtupefaction, dimneſs of ſight, dilatation of the pupil; and, where the injury done to the head is great, there is commonly a diſcharge of blood from the eyes, noſe, or ears. Sometimes the fractured bone can be diſcovered through the integuments, at other times it cannot. There is an irregular and oppreſſed pulſe, and ſnoring or apoplectic ſtertor in breathing. There is likewiſe nauſea and vomiting, with an involuntary diſcharge of fæces and urine. Among the muſcles of the extremities and other parts, there is loſs of voluntary motion, convulſive tremors in ſome parts of the body, and palſy in others, eſpecially in that ſide of the body which is oppoſite to the injured part of the head.

Some of the milder of theſe ſymptoms, as vertigo, ſtupefaction, and a temporary loſs of ſenſibility, are frequently induced by ſlight blows upon the head, but commonly ſoon diſappear, either by reſt alone, or by the means to be afterwards pointed out. But when any other ſymptoms enſue, ſuch as dilatation of the pupils, and eſpecially when much blood is diſcharged from the eyes, noſe, and ears, and that there is an involuntary diſcharge of fæces and urine, it may be reaſonably concluded that compreſſion of the brain is induced.

The cavity of the cranium, in the healthy and natural ſtate, is everywhere completely filled by the brain; whatever therefore diminiſhes that cavity, will produce a compreſſion of the brain.

32
Cauſes of theſe.

The cauſes producing ſuch a diminution may be of various kinds, as fracture and depreſſion of the bones of the cranium; the forcible introduction of any extraneous body into the cavity of the cranium; effuſion of blood, ſerum, pus, or any other fluid; the thickneſs and irregularity of the bones of the cranium in certain diſeaſes, as in lues venerea, rickets, or ſpina ventoſa; or water collected in hydrocephalous caſes. The firſt ſet of cauſes ſhall be conſidered in their order. The four laſt mentioned belong to the province of the phyſician, and have been conſidered in a former part of this work.

Fractures of the cranium have been differently diſtinguiſhed by different authors; but it ſeems ſufficient to divide them into thoſe attended with depreſſion, and thoſe which are not.

In fracture and depreſſion of the cranium, the treatment ought to be,—to diſcover the ſituation and extent of the fracture; and to obviate the effects of the injury done to the brain, by raiſing or removing all the depreſſed parts of the bone.

33
Method of diſcovering the ſituation of fractures of the cranium.

When the teguments correſponding to the injury done to the bone are cut or lacerated, and, as is ſometimes the caſe, entirely removed, the ſtate of the fracture is immediately diſcovered; but when the integuments of the ſkull remain entire, even though the general ſymptoms of fracture be preſent, there is ſometimes much difficulty in aſcertaining it. When, however, any external injury appears, particularly a tumor from a recent contuſion, attended by the ſymptoms already deſcribed, there can be no doubt of the exiſtence of a fracture. But it ſometimes happens that compreſſion exiſts without the ſmalleſt appearance of tumor. In ſuch caſes, the whole head ought to be ſhaved, when an inflammatory ſpot may frequently be obſerved. Sometimes the place of the fracture has been diſcovered by the patient applying the hand frequently on or near ſome particular part of the head.

When the ſymptoms of a compreſſed brain are evidently marked, no time ought to be loſt in ſetting about an examination of the ſtate of the cranium, wherever appearances point out, or even lead us to conjecture, in what part a fracture may be ſituated. For this purpoſe an inciſion is to be made upon the ſpot through the integuments to the ſurface of the bone, which muſt be ſufficiently expoſed to admit of a free examination.

Some authors have recommended a crucial inciſion; others one in form of the letter T; while many adviſe a conſiderable part of the integuments to be entirely removed. But as it is more agreeable to the preſent mode of practice to ſave as much of the ſkin as poſſible, a ſimple inciſion is generally preferred, unleſs the fracture run in different directions, and then the inciſion muſt vary accordingly. It will frequently happen, that a conſiderable part of the integuments muſt be ſeparated from the ſkull, in order to obtain a diſtinct view of the full extent of the fracture; but no part of the integuments is to be entirely removed.

When blood-veſſels of any conſiderable ſize are divided, either before or in time of the examination, they ought to be allowed to bleed freely, as in no caſe whatever is the loſs of blood attended with more advantage than the preſent. When, however, it appears that the patient has loſt a ſufficient quantity, the veſſels ought to be ſecured.

After the integuments have been divided, if the ſkull be found to be fractured and depreſſed, the nature of the caſe is rendered evident; but even where there is no external appearance of fracture, tumor, diſcoloration, or other injury, if the patient continue to labour under ſymptoms of a compreſſed brain, if the pericranium has been ſeparated from the bone, and eſpecially if the bone has loſt its natural appearance, and has acquired a pale white or duſky yellow hue, the trepan ought to be applied without heſitation at the place where theſe appearances mark the principal ſeat of the injury.

Again, although no mark either of fracture or of any diſeaſes underneath ſhould appear on the outer table of the bone, yet there is a poſſibility that the inner table may be fractured and depreſſed. This indeed is not a common occurrence, but it happens probably more frequently than ſurgeons have been aware of; and where it does happen, the injury done to the brain is as great, and attended with as much danger, as where the whole thickneſs of the bone is beat in. The application of the trepan is therefore neceſſary.

But if, after the application of the trepan, it happens that no mark of injury appears either in the outer or inner table in that part, or in the dura mater below it, and that the ſymptoms of a compreſſed brain ſtill continue, a fracture in ſome other part is to be ſuſpected; or that kind of fracture termed by practitioners *counter fiſſure*, where the ſkull is fractured and ſometimes depreſſed on the oppoſite ſide to, or at a diſtance from, the part where the injury was received. This is fortunately not a very frequent occurrence, and has even been doubted by ſome; but different inſtances of it have, beyond all queſtion, been found. If therefore the operation of the trepan has been performed, and no fracture is diſcovered, no extravaſation appears on the ſurface of the brain; and if blood-letting and other means uſually employed do not remove the ſymptoms of compreſſion, the operator is to ſearch for a fracture on ſome other part. The whole head ſhould again be examined with much accuracy; and, by preſſing deliberately but firmly over every part of it, if the ſmalleſt degree of ſenſibility remains, the patient will ſhow ſigns of pain, either by moans or by raiſing his hands, when preſſure is made over the fractured part. In this way fractures have been frequently detected, which might otherwiſe have been concealed.

34 Method of removing and elevating depreſſed portions of the cranium.

Having now conſidered every thing preparatory to the operation of the trepan, we ſhall next point out the means beſt adapted for the removal or elevation of a depreſſed portion of the bone.

The firſt thing to be done is, after ſhaving the head, to make an inciſion as deep as the bone, and directly upon the courſe of the fracture.

The patient ought to be laid on a table, with a mattreſs under him, while his head is placed upon a pillow, and ſecured by an aſſiſtant. When the extent of the fracture has been determined, and the bleeding from the inciſion ſtopped, the depreſſed bone is now to be elevated; but previous to this it is neceſſary to ſearch for detached pieces. Should any be found, they ought to be removed by a pair of forceps adapted to this purpoſe. By the ſame inſtrument any ſplinters of bone which may have been beaten in may be removed; but when a part of the bone is beaten in beyond the level of the reſt of the cranium, as much of the pericranium is then to be removed by a raſpatory, as will allow the trephine to be applied; or, if the operator incline, for the ſake of diſpatch, he may uſe the trepan; or the operation may be begun and finiſhed with the trephine, while the trepan may perform the middle and principal part of the work. This part of the work is begun by making a hole with the perforator, deep enough to fix the central pin of the trephine, in order to prevent the ſaw from ſlipping out of its central courſe, till it has formed a groove ſufficiently deep to be worked ſteadily in; and then the pin is to be removed. If the bone be thick, the teeth of the ſaw muſt be cleaned now and then by the bruſh during the perforation, and dipped in oil as often as it is cleaned, which will conſiderably facilitate the motion, and render it more expeditious; making it at the ſame time much leſs diſagreeable to the patient, if he poſſeſs his ſenſes. That no time may be loſt, the operator ought to be provided with two inſtruments of the ſame ſize, or at leaſt to have two heads which can be readily fitted to the ſame handle.

After having made ſome progreſs in the operation, the groove ought to be frequently examined with a picktooth, or ſome ſuch inſtrument, in order to diſcover its depth; and if one ſide happen to be deeper than the other, the operator ought to preſs more on that ſide which is ſhalloweſt. Precautions are more particularly neceſſary when the operation is performed upon a part of the ſkull which is of an unequal thickneſs, eſpecially after the inſtrument has paſſed the diploe. And though it be ſaid by writers in general that the inſtrument may be worked boldly till it comes at the diploe (which is generally known by the appearance of blood), yet the operator ſhould be upon his guard in this point, examining from time to time if the piece be looſe, leſt through inadvertence the dura mater be wounded; for in ſome parts of the ſkull there is naturally very little diploe, and in old ſubjects ſcarcely any. It ought likewiſe to be remembered, that the ſkulls of children are very thin. When the piece begins to vacillate, it ought to be ſnapped off with the forceps or levator; for the ſawing ought by no means to be continued till the bone be cut quite through, otherwiſe the inſtrument may plunge in upon the brain, or at leaſt injure the dura mater (B). If the inner edge of the perforation be left ragged, it is to be ſmoothed with the lenticular, to prevent it from irritating the dura mater. Particular care is to be taken in uſing the inſtrument, leſt it ſhould preſs too much upon the brain.

The next ſtep is to raiſe the depreſſed part of the bone with the levator, or to extract the fragments of the bone, grumous blood, or any extraneous body. After this, if there appear reaſon to apprehend that blood, lymph, or matter, is contained under the dura mater, it ought to be cautiouſly opened with a lancet, endeavouring to avoid the blood-veſſels running upon it, or lying immediately under it.

When the trepan is to be uſed on account of a fiſſure in which the bone will not yield, the inſtrument ſhould be applied ſo as to include part of it, if not directly over it, as it is moſt probable that the extravaſated fluid will be found directly under it. And when the fiſſure is of great extent, it may be proper to make a perforation at each end, if the whole can be conveniently brought into view; and in ſome caſes ſeveral perforations may become neceſſary.

When it is propoſed to make ſeveral perforations to remove depreſſed fragments of the bone which are firmly fixed, and having the internal ſurface larger than the external, or to raiſe them ſufficiently, it is neceſſary to apply the trepan as near the fractured parts as poſſible; making the perforations join each other, to prevent the trouble of cutting the intermediate ſpaces.

When the ſkull is injured over a ſuture, and it is no thought adviſable to uſe the trepan, a perforation ought to be made on each ſide of the ſuture, eſpecially in young ſubjects, in which the dura mater adheres more ſtrongly than in adults; becauſe there cannot be a free communication between the one ſide and the other, on account of the attachment of that membrane to the ſuture.

13 Treatment of the patient after the operation.

After the elevation of the depreſſed pieces, or the removal of thoſe which are quite looſe, the extraction of extraneous bodies, and the evacuation of extravaſated fluids, &c. the ſore is to be dreſſed in the lighteſt and eaſieſt manner; all that is neceſſary being to apply a pledget of fine ſcraped lint, covered with ſimple ointment, to that part of the dura mater which is laid bare by

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(B) A trepanning inſtrument has been invented by Mr Rodman, ſurgeon, Paiſley, which has no central pin, and it is ſo contrived that any given thickneſs of bone may be cut, ſo that the danger from other inſtruments is by the uſe of this entirely avoided. See a more detailed account of this inſtrument under ABAPTISTON.

by the trepan, or otherwiſe; after which the edges of the ſcalp are to be brought together or nearly ſo, and another pledget laid along the whole courſe of the wound; a piece of fine ſoft linen is to be laid over all, and the dreſſings may be retained in their place by a common night-cap applied cloſe to the head, and properly fixed.

The patient is to be placed in as eaſy a poſition in bed as poſſible, with his head and ſhoulders elevated a little more than ordinary. If the operation be attended with ſucceſs, the patient will ſoon begin to ſhow favourable ſymptoms; he will ſoon ſhow ſigns of increaſing ſenſibility, and the original bad ſymptoms will gradually diſappear. After this he ought to be kept as quiet as poſſible; proper laxatives are to be adminiſtered, and ſuch as may be leaſt of a nauſeating nature. His food ought to be ſimple and eaſy of digeſtion, and his drink of the moſt diluent kind. If he complain of the wound being uneaſy, an emollient poultice ſhould be immediately applied, and renewed three or four times in the twenty-four hours. By theſe means there will commonly be a free ſuppuration from the whole ſurface of the ſore.

Every time the wound is dreſſed, the purulent matter ought to be wiped off from it with a fine warm ſponge; and if any degree of ſloughineſs take place on the dura mater or parts adjacent, it will then be completely ſeparated. Granulations will begin to form, which will continue to increaſe till the whole ariſe to a level with the ſurface of the cranium. The edges of the ſore are now to be dreſſed with cerate ſtraps, and the reſt of it covered with fine ſoft lint, kept gently preſſed on by the night-cap properly tied. In this way the cure will go on favourably; luxuriance of granulations will commonly be prevented; the parts will cicatrize kindly; and as all the ſkin has been preſerved in making the firſt inciſion, the cicatrix will be but little obſerved.

But things do not always proceed in this favourable manner. Sometimes in a few hours after the operation the patient is ſeized with a kind of reſtleſſneſs, toſſing his arms, and endeavouring to move himſelf in bed, while the ſymptoms of a compreſſed brain remain nearly the ſame as formerly. In this caſe, eſpecially if the pulſe be quick and ſtrong, the patient ought to be bled freely, as there will be reaſon to ſuſpect ſome tendency to inflammation in the brain. Sometimes, though the trepan has been properly applied, the ſymptoms are not relieved, on account of extravaſated fluids collected internally under the dura mater, or between the pia mater and brain, or in the cavity of the ventricles. The danger in theſe caſes will be in proportion to the depth of the collection. Particular attention therefore ought always to be paid to the ſtate of the dura mater after the perforation has been made. If blood be collected below the dura mater, this membrane will be found tenſe, dark coloured, elaſtic, and even livid; in which caſe, an opening becomes abſolutely neceſſary to diſcharge the extravaſated fluid. Gentle ſcratches are to be made with a ſcalpel, till a probe or directory can be introduced; upon which the membrane is to be ſufficiently divided in a longitudinal, and ſometimes even in a crucial direction, till an outlet to the fluid be given.

After the dura mater has been cut in this manner, there is ſome danger of the brain protruding at the opening; but the danger from this is not equal to the bad effects ariſing from effuſed fluids compreſſing the brain.

36 Of fungi. A troubleſome and an alarming appearance now and then follows the operation of the trepan; namely, the excreſcences called *fungi*, formerly ſuppoſed to grow immediately from the ſurface of the brain, but which, in general, originate from the ſurface of the dura mater or cut edge of the bone granulating too luxuriantly.

It often happens that they poſſeſs little ſenſibility; and then the beſt method to prevent their riſing to any great height is to touch them frequently with lunar cauſtic: but ſome caſes occur where their ſenſibility is ſo great that they cannot be touched, unleſs they hang by a ſmall neck; and then a ligature may be put round them, and tightened from time to time till they drop off, which will commonly be in the courſe of a few days. It ſeldom happens, however, that there is any occaſion for applying ſuch means for the removal of theſe tumors, for they generally fall off as the perforations of the bone fill up.

If they do not, as the connection between them and the brain will be then in a great meaſure intercepted, they may be with more ſafety removed, either by exciſion, by cauſtic, or by ligature.

The cure being thus far completed, only a ſmall cicatrix will remain, and in general the parts will be nearly as firm as at firſt: but when much of the integuments have been ſeparated or deſtroyed, as they are never regenerated, the bone will be left covered only by a thin cuticle, with ſome ſmall quantity of cellular ſubſtance. When this is the caſe, the perſon ought to wear a piece of lead or tin, properly fitted and lined with flannel, to protect it from the cold and other external injuries.

This is the method now commonly practiſed in caſes of compreſſion; but it frequently happens, that inſtead of compreſſion, ſuch a degree of concuſſion takes place that no aſſiſtance from the trepan can be attended with any advantage; for the effects of concuſſion are totally different from thoſe of compreſſion, and therefore to be removed in a different manner.

Wounds, in *Farriery*. See Farriery *Index*.

WRASSE, or Old Wife. See Labrus, Ichthyology *Index*.

WREATH, in *Heraldry*, a roll of fine linen or ſilk (like that of a Turkiſh turban), conſiſting of the colours borne in the eſcutcheon, placed in an achievement between the helmet and the creſt, and immediately ſupporting the creſt.

WRECK, or Shipwreck, the deſtruction of a ſhip by rocks or ſhallows at ſea.

By the ancient common law, where any ſhip was loſt at ſea, and the goods or cargo were thrown upon the land, theſe goods, ſo wrecked, were judged to belong to the king: for it was held, that, by the loſs of the ſhip, all property was gone out of the original owner. But this was undoubtedly adding ſorrow to ſorrow, and was conſonant neither to reaſon nor humanity. Wherefore it was firſt ordained by King Henry I. that if any perſon eſcaped alive out of the ſhip, it ſhould be no wreck; and afterwards King Henry II. by his charter, declared, that if on the coaſts of either England, Poictou, Oleron, or Gaſcony, any ſhip ſhould be diſtreſſed, and

and either man or beaſt ſhould eſcape or be found therein alive, the goods ſhould remain to the owners, if they claimed them within three months; but otherwiſe ſhould be eſteemed a wreck, and ſhould belong to the king, or other lord of the franchiſe. This was again confirmed with improvements by King Richard I.; who, in the ſecond year of his reign, not only eſtabliſhed theſe conceſſions, by ordaining that the owner, if he was ſhipwrecked and eſcaped, *omnes res ſuas liberas et quietas haberet*, but alſo, that if he periſhed, his children, or in default of them, his brethren and ſiſters, ſhould retain the property; and in default of brother or ſiſter, then the goods ſhould remain to the king (A). And the law, as laid down by Bracton in the reign of Henry III. ſeems ſtill to have improved in its equity. For then, if not only a dog (for inſtance) eſcaped, by which the owner might be diſcovered, but if any certain mark were ſet on the goods, by which they might be known again, it was held to be no wreck. And this is certainly moſt agreeable to reaſon; the rational claim of the king being only founded upon this, that the true owner cannot be aſcertained. Afterwards, in the firſt ſtatute of Weſtminſter, the time of limitation of claims, given by the charter of Henry II. is extended to a year and a day, according to the uſage of Normandy: and it enacts, that if any man, a dog, or a cat, eſcape alive, the veſſel ſhall not be adjudged a wreck. Theſe animals, as in Bracton, are only put for examples; for it is now held, that not only if any live thing eſcape, but if proof can be made of the property of any of the goods or lading which come to ſhore, they ſhall not be forfeited as wreck. The ſtatute further ordains, that the ſheriff of the county ſhall be bound to keep the goods a year and a day (as in France for one year, agreeable to the maritime laws of Oleron, and in Holland for a year and a half), that if any man can prove a property in them, either in his own right or by right of repreſentation, they ſhall be reſtored to him without delay; but if no ſuch property be proved within that time, they then ſhall be the king's. If the goods are of a periſhable nature, the ſheriff may ſell them, and the money ſhall be liable in their ſtead. This revenue of wrecks is frequently granted out to lords of manors as a royal franchiſe; and if any one be thus intitled to wrecks in his own land, and the king's goods are wrecked thereon, the king may claim them at any time, even after the year and day.

It is to be obſerved, that, in order to conſtitute a legal wreck, the goods muſt come to land. If they continue at ſea, the law diſtinguiſhes them by the barbarous and uncouth appellations of *jetſam*, *flotſam*, and *ligan*. Jetſam is where goods are caſt into the ſea, and there ſink and remain under water: flotſam is where they continue ſwimming on the ſurface of the waves: ligan is where they are ſunk in the ſea, but tied to a cork or buoy, in order to be found again. Theſe are alſo the king's, if no owner appears to claim them; but if any owner appears, he is intitled to recover the poſſeſſion. For even if they be caſt overboard, without any mark or buoy, in order to lighten the ſhip, the owner is not by this act of neceſſity conſtrued to have renounced his property: much leſs can things ligan be ſuppoſed to be abandoned, ſince the owner has done all in his power to aſſert and retain his property. Theſe three are therefore accounted ſo far a diſtinct thing from the former, that by the king's grant to a man of wrecks, things jetſam, flotſam, and ligan, will not paſs.

Wrecks, in their legal acceptation, are at preſent not very frequent: for if any goods come to land, it rarely happens, ſince the improvement of commerce, navigation, and correſpondence, that the owner is not able to aſſert his property within the year and day limited by law. And in order to preſerve this property entire for him, and if poſſible to prevent wrecks at all, our laws have made many very humane regulations; in a ſpirit quite oppoſite to thoſe ſavage laws which formerly prevailed in all the northern regions of Europe, and a few years ago were ſtill ſaid to ſubſiſt on the coaſts of the Baltic ſea, permitting the inhabitants to ſeize on whatever they could get as lawful prize; or, as an author of their own expreſſes it, "*in naufragorum miſeria et calamitate tanquam vultures ad prædam currere.*" For by the ſtatute 27 Edw. III. c. 13. if any ſhip be loſt on the ſhore, and the goods come to land (which cannot, ſays the ſtatute, be called *wreck*), they ſhall be preſently delivered to the merchants, paying only a reaſonable reward to thoſe that ſaved and preſerved them, which is intitled *ſalvage*. Alſo by the common law, if any perſons (other than the ſheriff) take any goods ſo caſt on ſhore, which are not legal wreck, the owners might have a commiſſion to inquire and find them out, and compel them to make reſtitution. And by 12 Ann. ſtat. 2. c. 18. confirmed by 4 Geo. I. c. 12. in order to aſſiſt the diſtreſſed, and prevent the ſcandalous illegal practices on ſome of our ſea-coaſts (too ſimilar to thoſe on the Baltic), it is enacted, that all head-officers and others of towns near the ſea, ſhall, upon application made to them, ſummon as many hands as are neceſſary, and ſend them to the relief of any ſhip in diſtreſs, on forfeiture of 100l.; and in caſe of aſſiſtance given, ſalvage ſhall be paid by the owners, to be aſſeſſed by three neighbouring juſtices. All perſons that ſecrete any goods ſhall forfeit their treble value; and if they wilfully do any act whereby the ſhip is loſt or deſtroyed, by making holes in her, ſtealing her pumps, or otherwiſe, they are guilty of felony without benefit of clergy. Laſtly, by the ſtatute 26 Geo. II. c. 19. plundering any veſſel, either in diſtreſs or wrecked, and whether any living creature be on board or not (for whether wreck or otherwiſe, it is clearly not the property of the populace), ſuch plundering or preventing the eſcape of any perſon that endeavours to ſave his life, or wounding him with intent to deſtroy him, or putting out falſe lights in order to bring any veſſel into danger, are all declared to be capital felonies; in like manner as the deſtroying of trees, ſteeples, or other ſtated ſea-marks,

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(A) In like manner Conſtantine the Great, finding that by the imperial law the revenue of wrecks was given to the prince's treaſury or fiſcus, reſtrained it by an edict (Cod. 11. 5. 1.) and ordered them to remain to the owners; adding this humane expoſtulation: "Quod enim jus habet fiſcus in aliena calamitate, ut de re tam luctuoſa compendium ſectetur."

is puniſhed by the ſtatute 8 Eliz. c. 13. with a forfeiture of 100l. or outlawry. Moreover, by the ſtatute of Geo. II. pilfering any goods caſt aſhore is declared to be petty larceny; and many other ſalutary regulations are made, for the more effectually preſerving ſhips of any nation in diſtreſs.

By the civil law, to deſtroy perſons ſhipwrecked, or prevent their ſaving the ſhip, is capital. And to ſteal even a plank from a veſſel in diſtreſs or wrecked, makes the party liable to anſwer for the whole ſhip and cargo. The laws alſo of the Wiſigoths, and the moſt early Neapolitan conſtitutions, puniſhed with the utmoſt ſeverity all thoſe who neglected to aſſiſt any ſhip in diſtreſs, or plundered any goods caſt on ſhore.

WREN. See MOTACILLA, ORNITHOLOGY *Index*.

WREN, *Sir Chriſtopher*, a great philoſopher, and one of the moſt learned and moſt eminent architects of his age, was the ſon of Chriſtopher Wren dean of Windſor, and was born in 1632. He ſtudied at Wadham college in Oxford; where he took the degree of maſter of arts in 1653, and was choſen fellow of All Souls college. When very young he diſcovered a ſurpriſing genius for the mathematics; in which ſcience he made great advances before he was ſixteen years old. In 1657, he was made profeſſor of aſtronomy at Greſham college, London; which he reſigned in 1660, on his being choſen to the Savilian profeſſorſhip of aſtronomy in Oxford: he was next year created doctor of laws, and in 1663 was elected fellow of the Royal Society. He was one of the commiſſioners for the reparation of St Paul's; and in 1665 travelled into France, to examine the moſt beautiful edifices there, when he made many curious obſervations. At his return to England, he drew a noble plan for rebuilding the city of London after the fire, which he preſented to parliament; and upon the deceaſe of Sir John Denham in 1668, was made ſurveyor-general of his majeſty's works; and from that time had the direction of a great number of public edifices, by which he acquired the higheſt reputation. He built the magnificent theatre at Oxford, St Paul's cathedral, the churches of St Stephen Walbrook, and St Mary-le-Bow, the Monument, the modern part of the palace of Hampton Court, Chelſea college, one of the wings of Greenwich hoſpital, and many other beautiful edifices. He was preſident of the Royal Society, one of the commiſſioners of Chelſea college, and twice member of parliament; firſt for Plymouth in Devonſhire, and then for Melcomb Regis in the ſame county; but in 1718 was removed from his place of ſurveyor-general. He died in 1723, and was interred in the vault under St Paul's.

This great man alſo diſtinguiſhed himſelf by many curious inventions and diſcoveries in natural philoſophy; and, among many others, contrived an inſtrument for meaſuring the quantity of rain that falls on any ſpace of land for a year; he invented many ways of making aſtronomical obſervations more accurate and eaſy; and was the firſt author of the anatomical experiment of injecting liquors into the veins of animals, &c. He tranſlated into Latin Mr Oughtred's *Horologiographica Geometrica*; and wrote a Survey of the cathedral church of Saliſbury, and other pieces. After his death his poſthumous works and draughts were publiſhed by his ſon.

WRESTLING, a kind of combat or engagement between two perſons unarmed, body to body, to prove their ſtrength and dexterity, and try which can throw his opponent to the ground.

Wreſtling is an excerciſe of very great antiquity and fame. It was in uſe in the heroic age; witneſs Hercules, who wreſtled with Antæus.

It continued a long time in the higheſt repute, and had conſiderable rewards and honours aſſigned to it at the Olympic games. It was the cuſtom for the athletæ to anoint their bodies with oil, to give the leſs hold to their antagoniſts.

Lycurgus ordered the Spartan maids to wreſtle in public quite naked, in order, as it is obſerved, to break them of their too much delicacy and niceneſs, to make them appear more robuſt, and to familiarize the people, &c. to ſuch nudities.

WRIST, in *Anatomy*. See there, N° 53.

WRIT, in *Law*, ſignifies, in general, the king's precept in writing under ſeal, iſſuing out of ſome court, directed to the ſheriff or other officer, and commanding ſomething to be done in relation to a ſuit or action, or giving commiſſion to have the ſame done. And, according to Fitzherbert, a writ is ſaid to be a formal letter of the king in parchment, ſealed with his ſeal, and directed to ſome judge, officer, or miniſter, &c. at the ſuit of a ſubject, for the cauſe briefly expreſſed, which is to be determined in the proper court according to law.

WRITS, in civil actions, are either original or judicial: original, are ſuch as are iſſued out of the court of chancery for the ſummoning of a defendant to appear, and are granted before the ſuit is commenced, in order to begin the ſame; and judicial writs iſſue out of the court where the original is returned, after the ſuit is begun. See PROCESS.

The original writ is the foundation of the ſuit. See SUIT.

When a perſon hath received an injury, and thinks it worth his while to demand a ſatisfaction for it, he is to conſider with himſelf, or take advice, what redreſs the law has given for that injury; and thereupon is to make application or ſuit to the crown, the fountain of all juſtice, for that particular ſpecific remedy which he is determined or adviſed to purſue. As for money due on bond, an action of debt; for goods detained without force, an action of *detenue* or *trover*; or, if taken with force, an action of *treſpaſs vi et armis*; or, to try the title of lands, a writ of entry or action of treſpaſs in ejectment; or for any conſequential injury received, a ſpecial action on the caſe. To this end he is to ſue out, or purchaſe by paying the ſtated fees, an *original* or original writ, from the court of chancery, which is the *officina juſtitiæ*, the ſhop or mint of juſtice, wherein all the king's writs are framed. It is a mandatory letter from the king in parchment, ſealed with his great ſeal, and directed to the ſheriff of the county wherein the injury is committed, or ſuppoſed ſo to be, requiring him to command the wrong-doer or party accuſed, either to do juſtice to the complainant, or elſe to appear in court, and anſwer the accuſation againſt him. Whatever the ſheriff does in purſuance of this writ, he muſt return or certify to the court of common-pleas, together with the writ itſelf: which is the foundation of the juriſdiction of that court, being the king's warrant for the judges to proceed to the determination of the cauſe. For it was a maxim introduced by the Normans, that there ſhould be be no proceedings in common-pleas before the king's juſtices without his original writ; becauſe they held it unfit that thoſe juſtices, being only the ſubſtitutes of the crown, ſhould take cognizance of any thing but what was thus expreſsly referred to their judgement. However, in ſmall actions, below the value of forty ſhillings, which are brought in the court-baron or county-court, no royal writ is neceſſary; but the foundation of ſuch ſuits continue to be (as in the times of the Saxons), not by original writ, but by plaint; that is, by a private memorial tendered in open court to the judge, wherein the party injured ſets forth his cauſe of action: and the judge is bound of common right to adminiſter juſtice therein, without any ſpecial mandate from the king. Now indeed even the royal writs are held to be demandable of common right, on paying the uſual fees: for any delay in the granting them, or ſetting an unuſual or exorbitant price upon them, would be a breach of magna charta, c. 29. "nulli vendemus, nulli negabimus, aut differemus juſtitiam vel rectum."

Original writs are either optional or peremptory; or, in the language of our law, they are either a *præcipe* or a *ſi te fecerit ſecurum*. The *præcipe* is in the alternative, commanding the defendant to do the thing required, or ſhow the reaſon wherefore he hath not done it. The uſe of this writ is where ſomething certain is demanded by the plaintiff, which is in the power of the defendant himſelf to perform; as, to reſtore the poſſeſſion of land, to pay a certain liquidated debt, to perform a ſpecific covenant, to render an account, and the like; in all which caſes the writ is drawn up in the form of a *præcipe* or command, to do thus, or ſhow cauſe to the contrary; giving the defendant his choice to redreſs the injury or ſtand the ſuit. The other ſpecies of original writs is called a *ſi fecerit te ſecurum*, from the words of the writ; which directs the ſheriff to cauſe the defendant to appear in court, without any option given him, provided the plaintiff gives the ſheriff ſecurity effectually to proſecute his claim. This writ is in uſe where nothing is ſpecifically demanded, but only a ſatisfaction in general; to obtain which, and miniſter complete redreſs, the intervention of ſome judicature is neceſſary. Such are writs of treſpaſs, or on the caſe, wherein no debt or other ſpecific thing is ſued for in certain, but only damages to be aſſeſſed by a jury. For this end the defendant is immediately called upon to appear in court, provided the plaintiff gives good ſecurity of proſecuting his claim. Both ſpecies of writs are teſted, or witneſſed, in the king's own name; "witneſs ourſelf at Weſtminſter," or wherever the chancery may be held.

The ſecurity here ſpoken of, to be given by the plaintiff for proſecuting his claim, is common to both writs, though it gives denomination only to the latter. The whole of it is at preſent become a mere matter of form; and John Doe and Richard Roe are always returned as the ſtanding pledges for this purpoſe.—The ancient uſe of them was to anſwer for the plaintiff, who in caſe he brought an action without cauſe, or failed in the proſecution of it when brought, was liable to an amercement from the crown for raiſing a falſe accuſation; and ſo the form of the judgement ſtill is. In like manner, as by the Gothic conſtitutions no perſon was permitted to lay a complaint againſt another *niſi ſub ſcriptura aut ſpecificatione trium teſtium, quod actionem vellet perſequi*: and, as by the laws of Sancho I. king of Portugal, damages were given againſt a plaintiff who proſecuted a groundleſs action.

The day on which the defendant is ordered to appear in court, and on which the ſheriff is to bring in the writ, and report how far he has obeyed it, is called the *return of the writ*; it being then returned by him to the king's juſtices at Weſtminſter. And it is always made returnable at the diſtance of at leaſt 15 days from the date or teſt, that the defendant may have time to come up to Weſtminſter, even from the moſt remote parts of the kingdom; and upon ſome day in one of the four terms, in which the court ſits for the diſpatch of buſineſs.

WRITING, the art or act of ſignifying and conveying our ideas to others, by letters or characters viſible to the eye. See COMPOSITION, GRAMMAR, and LANGUAGE.

The moſt ancient remains of writing, which have been tranſmitted to us, are upon hard ſubſtances, ſuch as ſtones and metals, which were uſed by the ancients for edicts and matters of public notoriety; the decalogue was written on two tables of ſtone; but this practice was not peculiar to the Jews, for it was uſed by moſt of the eaſtern nations, as well as by the Greeks and Romans; and therefore the ridicule which Voltaire attempts to caſt upon that part of the book of Geneſis, where the people are commanded to write the law on ſtones, is abſurd; for what is there ſaid by no means implies, that other materials might not be uſed on common occaſions. The laws penal, civil, and ceremonial, among the Greeks, were engraven on tables of braſs which were called *cyrbes*.

We find that wood was alſo uſed for writing on in different countries. In the Sloanian library (N^{o} 4852.) are ſix ſpecimens of Kufic writing, on boards about two feet in length, and ſix inches in depth. The Chineſe, before the invention of paper, wrote or engraved with an iron tool upon thin boards or on bamboo. Pliny ſays, that table books of wood were in uſe before the time of Homer. Theſe table books were called by the Romans *pugillares*. The wood was cut into thin ſlices, and finely plained and poliſhed. The writing was at firſt upon the bare wood, with an iron inſtrument called a *ſtyle*. In later times theſe tables were uſually waxed over, and written upon with that inſtrument. The matter written upon the tables which were thus waxed over was eaſily effaced, and by ſmoothing the wax new matter might be ſubſtituted in the place of what had been written before. The Greeks and Romans continued the uſe of waxed table-books long after the uſe of papyrus, leaves, and ſkins, became common, becauſe they were ſo convenient for correcting extemporary compoſitions.

Table books of ivory are ſtill uſed for memorandums, but they are commonly written upon with black lead pencils. The practice of writing on table-books covered with wax was not entirely laid aſide till the commencement of the 14th century.

The bark of trees was alſo uſed for writing by the ancients, and is ſo ſtill in ſeveral parts of Aſia. The ſame thing may be ſaid of the leaves of trees. It is needleſs to obſerve the uſe of parchment and vellum, papyrus and paper, for writing; it is too well known.

The method of fabricating theſe ſubſtances has been already deſcribed as they occurred in the order of the alphabet.

It is obvious, that when men wrote, or rather engraved, on hard ſubſtances, inſtruments of metal were neceſſary, ſuch as the chiſel and the ſtylus; but the latter was chiefly uſed for writing upon boards, waxed tablets, or on bark.

When the ancients wrote on ſofter materials than wood or metal, other inſtruments were uſed for writing with, of which reeds and canes ſeem to have been the firſt. Reeds and canes are ſtill uſed as inſtruments for writing with by the Tartars, the Indians, the Perſians, the Turks, and the Greeks. Pencils made of hair are uſed by the Chineſe for their writing: they firſt liquefy their ink, and dip their pencils into it. Hair-pencils have likewiſe been uſed for writing in Europe. Large capital letters were made with them from the time of the Roman emperors till the 16th century. After the invention of printing they were drawn by the illuminators. Quills of geeſe, ſwans, peacocks, crows, and other birds, have been uſed in theſe weſtern parts for writing with, but how long is not eaſy to aſcertain. St Iſidore of Seville, who lived about the middle of the 7th century, deſcribes a pen made of a quill as uſed in his time.

Method of reſtoring decayed WRITINGS. In the 77th volume of the Phil. Tranſ. there is a paper on this ſubject by Sir Charles Blagden. One of the beſt methods he found upon experiment to be, covering the letters with phlogiſticated or pruſſic alkali, with the addition of a diluted mineral acid; upon the application of which, the letters changed very ſpeedily to a deep blue colour, of great beauty and intenſity. To prevent the ſpreading of the colour, which, by blotting the parchment, detracts greatly from the legibility, the alkali ſhould be put on firſt, and the diluted acid added upon it. The method found to anſwer beſt has been, to ſpread the alkali thin with a feather over the traces of the letters, and then to touch it gently, as nearly upon or over the letters as can be done with the diluted acid, by means of a feather or a bit of ſtick cut to a blunt point. Though the alkali ſhould occaſion no ſenſible change of colour, yet the moment the acid comes upon it, every trace of a letter turns at once to a fine blue, which ſoon acquires its full intenſity, and is beyond compariſon ſtronger than the colour of the original trace had been. If, then, the corner of a bit of blotting paper be carefully and dexterouſly applied near the letters, ſo as to imbibe the ſuperfluous liquor, the ſtaining of the parchment may be in a great meaſure avoided; for it is this ſuperfluous liquor which, abſorbing part of the colouring matter from the letters, becomes a dye to whatever it touches. Care muſt be taken not to bring the blotting paper in contact with the letters, becauſe the colouring matter is ſoft whilſt wet, and may eaſily be rubbed off. The acid chiefly employed was the marine; but both the vitriolic and nitrous ſucceed very well. They ſhould be ſo far diluted as not to be in danger of corroding the parchment, after which the degree of ſtrength does not ſeem to be a matter of much nicety.

Method of Copying WRITINGS. The ingenious Mr Watt, ſome years ago, invented a method of copying writings very ſpeedily, and without the poſſibility of committing miſtakes. A piece of thin unſized paper is to be taken exactly of the ſize of the paper to be copied; it is to be moiſtened with water, or, what is better, with the following liquid: Take of diſtilled vinegar two pounds weight, diſſolve it in one ounce of boracic acid; then take four ounces of oyſter-ſhells calcined to whiteneſs, and carefully freed from their brown cruſt; put them into the vinegar, ſhake the mixture frequently for 24 hours, then let it ſtand until it depoſits its ſediment; filter the clear part through unſized paper into a glaſs veſſel; then add two ounces of the beſt blue Aleppo galls bruiſed, and place the liquor in a warm place, ſhaking it frequently for 24 hours; then filter the liquor again through unſized paper, and add to it after filtration one quart, ale meaſure, of pure water. It muſt then ſtand 24 hours, and be filtered again if it ſhows a diſpoſition to depoſit any ſediment, which it generally does. When the paper has been wet with this liquid, put it between two thick unſized papers to abſorb the ſuperfluous moiſture; then lay it over the writing to be copied, and put a piece of clean writing paper above it. Put the whole on the board of a rolling-preſs, and preſs them through the rolls, as is done in printing copperplates, and a copy of the writing ſhall appear on both ſides of the thin moiſtened paper; on one ſide in a reverſed order and direction, but on the other ſide in the natural order and direction of the lines.

WRITTEN MOUNTAINS. See MOUNTAINS.

WRY-NECK. See JYNX, ORNITHOLOGY *Index*.

WURTEMBURG, or WIRTENBERG, a ſovereign duchy of Germany, in Suabia; bounded on the north by Franconia, the archbiſhopric of Mentz, and the palatinate of the Rhine; on the eaſt by the county of Oeting, the marquiſate of Burgau, and the territory of Ulm; on the ſouth by the principality of Hoen-Zollern, Furſtenburg, and the marquiſate of Hohenburg; and on the weſt by the palatinate of the Rhine, the marquiſate of Baden, and the Black Foreſt. It is 65 miles in length, and as much in breadth, and the river Neckar runs almoſt through the middle of it from ſouth to north. Though there are many mountains and woods, yet it is one of the moſt populous and fertile countries in Germany, producing plenty of graſs, corn, fruits, and a great deal of wine towards the confines of the palatinate. There are alſo mines, and ſalt ſprings, with plenty of game and fiſh. It contains 645 villages, 88 towns, and 26 cities, of which Stutgard is the capital.

WURTSBURG, a large biſhopric in Germany, comprehending the principal part of Franconia. It is bounded by the county of Henneburg, the duchy of Coburg, the abbey of Fuld, the archbiſhopric of Mentz, the marquiſate of Anſpach, the biſhopric of Bamberg, and the county of Wertheim; being about 65 miles in length, and 50 in breadth, and divided into 50 bailiwicks. The ſoil is very fertile, and produces more corn and wine than the inhabitants conſume. The territories of the biſhop comprehend above 400 towns and villages, of which he is ſovereign, being one of the greateſt eccleſiaſtical princes of the empire.

WURTZBURG, a large and handſome city of Germany, and one of the principal in the circle of Franconia. It is defended with good fortifications, and has a magnificent palace. There is a handſome hoſpital, in which are generally 400 poor men and women. The caſtle is at a ſmall diſtance from the city, and commands it, as it ſtands upon an eminence. It communicates with the city by a ſtone bridge, on which are 12 ſtatues, repreſenting as many ſaints. The arſenal and the cellars of the biſhop deſerve the attention of the curious. There is alſo an univerſity, founded in 1403. It is ſeated on the river Maine, in E. Long. 10. 2. N. Lat. 49. 40.

WYCHERLEY, William, an eminent Engliſh comic poet, was born about 1640. A little before the reſtoration of King Charles II. he became a gentleman commoner of Queen's college Oxford, where he was reconciled by Dr Barlow to the Proteſtant religion, which he had a little before abandoned in his travels. He afterwards entered himſelf in the Middle-temple, but ſoon quitted the ſtudy of the law for purſuits more agreeable to his own genius, as well as to the taſte of the age. Upon writing his firſt play, entitled, Love in a Wood, or St James's Park, which was acted in 1672, he became acquainted with ſeveral of the celebrated wits both of the court and town, and likewiſe with the ducheſs of Cleveland. Some time after appeared his comedies, called The Gentleman Dancing Maſter, the Plain Dealer, and the Country Wife; all which were acted with applauſe. George duke of Buckingham had a very high eſteem for him, and beſtowed on him ſeveral advantageous poſts. King Charles alſo ſhowed him ſignal marks of favour; and once gave him a proof of his eſteem, which perhaps never any ſovereign prince before had given to a private gentleman. Mr Wycherley being ill of a fever, at his lodgings in Bow-ſtreet, the king did him the honour of a viſit. Finding him extremely weakened, he commanded him to take a journey to the ſouth of France, and aſſured him, at the ſame time, that he would order him 500l. to defray the charges of the journey. Mr Wycherley accordingly went into France; and having ſpent the winter there, returned to England entirely reſtored to his former vigour. The king, ſhortly after his arrival, told him, that he had a ſon, who he was reſolved ſhould be educated like the ſon of a king, and that he could not chooſe a more proper man for his governor than Mr Wycherly; for which ſervice 1500l. *per annum* ſhould be ſettled upon him.

Immediately after this offer he went to Tunbridge, where walking one day upon the Well's walk with his friend Mr Fairbeard, of Gray's Inn, juſt as he came up to the bookſeller's ſhop, the counteſs of Drogheda, a young widow, rich, noble, and beautiful, came there to inquire for the Plain Dealer; "Madam," ſays Mr Fairbeard, "ſince you are for the Plain Dealer, there he is for you;" puſhing Mr Wycherley towards her. "Yes," ſays Mr Wycherly, "this lady can bear plain dealing; for ſhe appears to be ſo accompliſhed, that what would be a compliment to others, would be plain dealing to her." "No, truly, Sir," ſaid the counteſs, "I am not without my faults, any more than the reſt of my ſex; and yet notwithſtanding, I love plain dealing, and am never more fond of it than when it tells me of them." "Then, madam," ſays Mr Fairbeard, "you and the Plain Dealer ſeem deſigned by Heaven for each other."—In ſhort, Mr Wycherley walked a turn or two with the counteſs, waited upon her home, viſited her daily while ſhe ſtaid at Tunbridge, and married her ſoon after without acquainting the king. By this ſtep, which was looked upon as a contempt of his majeſty's orders, he forfeited the royal favour. The counteſs of Drogheda ſettled her whole fortune upon him; but his title being diſputed after her death, he was ſo reduced by the expences of the law and other incumbrances, as to be unable to ſatisfy the impatience of his creditors, who threw him into priſon; and the bookſeller who printed his Plain Dealer, by which he got almoſt as much money as the other gained reputation, was ſo ungrateful as to refuſe to lend him 20l. in his extreme neceſſity. In that confinement he languiſhed ſeven years; but at length King James going to ſee the above play, was ſo charmed with it, that he gave immediate orders for the payment of his debts, and even granted him a penſion of 200l. *per annum*. But the prince's bountiful intentions were a great meaſure defeated merely through Mr Wycherley's modeſty; he being aſhamed to tell the earl of Mulgrave, whom the king had ſent to demand it, a true ſtate of his debts. He laboured under the weight of theſe difficulties till his father died, who left him 600l. a-year. But this eſtate was under limitations, he being only a tenant for life, and not being allowed to raiſe any money for the payment of his debts. However, he took a method of doing it which few ſuſpected to be his choice; and this was making a jointure. He had often declared, that he was reſolved to die married, though he could not bear the thoughts of living in that ſtate again: accordingly, juſt at the eve of his death, he married a young gentlewoman with 1500l. fortune, part of which he applied to the uſes he wanted it for. Eleven days after the celebration of theſe nuptials, in December 1715, he died, and was interred in the vault of Covent-garden church.

Beſides his plays above mentioned, he publiſhed a volume of poems in folio. In 1728 his poſthumous works in proſe and verſe were publiſhed by Mr Theobald.

WYNDHAM, Sir William, deſcended of an ancient family, was born about the year 1687, and ſucceeded young to the title and eſtate of his father. On his return from his travels, he was choſen member for the county of Somerſet; in which ſtation he ſerved in the three laſt parliaments of Queen Anne, and as long as he lived: after the change of the miniſtry in 1710, he was appointed ſecretary at war; and in 1713 was raiſed to be chancellor of the exchequer. Upon the breach between the earl of Oxford and Lord Bolingbroke, he adhered to the intereſts of the latter. He was removed from his employment on the acceſſion of George I. and falling under ſuſpicion on the breaking out of the rebellion in 1715, was apprehended. He made his eſcape; a reward was publiſhed for apprehending him; he ſurrendered, was committed to the Tower, but never brought to a trial. After he regained his liberty, he continued in oppoſition to the ſeveral adminiſtrations under which he lived; and died in 1740.

WYE, a river of South Wales, which iſſuing out of Plinlymmon Hill, very near the ſource of the Severn, croſſes the north-eaſt corner of Radnorſhire, giving name to the town of Rhyadergowy (Fall of the Wye), where it is precipitated in a cataract: then flowing between this county and Brecknockſhire, it croſſes Herefordſhire, and dividing the counties of Glouceſter and Monmouth, falls into the mouth of the Severn, below Chepſtow. The romantic beauties of the Wye, which flows in a deep bed, between lofty rocks clothed with hanging woods, and here and there crowned by ruined caſtles, have employed the deſcriptive powers of the pen and pencil.

Wye is alſo the name of a river in Derbyſhire, which riſes in the north-weſt part, above Buxton; and, flowing ſouth-eaſt, falls into the Derwent, below Bakewell.

Wye, the name of a town in Kent, with a market on Thurſday, ſeated on the Stour, 10 miles ſouth of Canterbury, and 59. ſouth-eaſt of London. E. Long. 1. 4. N. Lat. 51. 10.

Wye, a town of Switzerland, in a territory of the abbey of St Gallen, with a palace. It is built on an eminence 16 miles ſouth ſouth-weſt of Conſtance. E. Long. 9. 4. N. Lat. 47. 34.

X.

X, or x, is the 22d letter of our alphabet, and a double conſonant. It was not uſed by the Hebrews or ancient Greeks; for, as it is a compound letter, the ancients, who uſed great ſimplicity in their writings, expreſſed this letter by its component letters *c s*. Neither have the Italians this letter, but expreſs it by *ſſ*. X begins no word in our language but ſuch as are of Greek original; and is in few others but what are of Latin derivation; as *perplex*, *reflexion*, *defluxion*, &c. We often expreſs this ſound by ſingle letters, as *cks*, in *backs*, *necks*; by *ks*, in *books*, *breaks*; by *cc*, in *acceſs*, *accident*; by *ct*, in *action*, *unction*, &c. The Engliſh and French pronounce it like *cs* or *ks*; the Spaniards like *c* before *a*, viz. *Alexandro*, as it were *Alecandro*. In numerals it expreſſeth 10, whence in old Roman manuſcripts it is uſed for *denarius*; and as ſuch ſeems to be made of two V's placed one over the other. When a daſh is added over it, thus X̄, it ſignifies 10,000.

XANTHIUM, a genus of plants of the claſs *monœcia*, and arranged in the natural claſſification under the 49th order, *compoſitæ*. See Botany *Index*.

XANTHOXYLUM. See Zanthoxylum.

XEBEC, or Zebec, a ſmall three-maſted veſſel, navigated in the Mediterranean ſea, and on the coaſts of Spain, Portugal, and Barbary. See Plate fig. 10.

The ſails of the xebec are in general ſimilar to thoſe of the poleacre, but the hull is extremely different from that and almoſt every other veſſel. It is furniſhed with a ſtrong prow: and the extremity of the ſtern, which is nothing more than a ſort of railed platform or gallery, projects farther behind the counter and buttock than that of any European ſhip.

Being generally equipped as a corſair, the xebec is conſtructed with a narrow floor, to be more ſwift in purſuit of the enemy; and of a great breadth, to enable her to carry a greater force of ſail for this purpoſe without danger of overturning. As theſe veſſels are uſually very low built, their decks are formed with a great convexity from the middle of their breadth towards the ſides, in order to carry off the water which falls aboard more readily by their ſcuppers. But as this extreme convexity would render it very difficult to walk thereon at ſea, particularly when the veſſel rocks by the agitation of the waves, there is a platform of grating extending along the deck from the ſides of the veſſel towards the middle, whereon the crew may walk dry-footed whilſt the water is conveyed through the grating to the ſcuppers.

The xebecs, which are generally armed as veſſels of war by the Algerines, mount from 16 to 24 cannon, and carry from 300 to 450 men, two-thirds of whom are generally ſoldiers.

By the very complicated and inconvenient method of working theſe veſſels, what one of their captains of Algiers told Mr Falconer will be readily believed, viz. that every xebec requires at leaſt the labour of three ſquare-rigged ſhips, wherein the ſtanding ſails are calculated to anſwer every ſituation of the wind.

XENOCRATES, a celebrated ancient Grecian philoſopher, was born at Chalcedon in the 95th Olympiad. At firſt he attached himſelf to Æſchines, but afterwards became a diſciple of Plato, who took much pains in cultivating his genius, which was naturally heavy. His temper was gloomy, his aſpect ſevere, and his manners little tinctured with urbanity. Theſe material defects his maſter took great pains to correct; frequently adviſing him to ſacrifice to the Graces: and the pupil was patient of inſtruction, and knew how to value the kindneſs of his preceptor. As long as Plato lived, Xenocrates was one of his moſt eſteemed diſciples; after his death he cloſely adhered to his doctrine; and, in the ſecond year of the 110th Olympiad, he took the chair in the academy, as the ſucceſſor of Speuſippus.

Xenocrates was celebrated among the Athenians, not only for his wiſdom, but for his virtues. So eminent was his reputation for integrity, that when he was called upon to give evidence in a judicial tranſaction, in which an oath was uſually required, the judges unanimouſly agreed, that his ſimple aſſervation ſhould be taken, as a public teſtimony to his merit. Even Philip of Macedon found it impoſſible to corrupt him. So abſtemious was he with reſpect to food, that his proviſion was frequently ſpoiled before it was conſumed. His chaſtity was invincible. Phryne, a celebrated Athenian courtezan, attempted without ſucceſs to ſeduce him. Of his humanity the following pathetic incident is a ſufficient proof: A ſparrow, which was purſued by a hawk, flew into his boſom; he afforded it protection till its enemy was out of ſight, and then let it go, ſaying, that he would never betray a ſuppliant. He was fond of retirement, and was ſeldom ſeen in the city. He was diſcreet in the uſe of his time, and carefully allotted a certain portion of each day

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day to its proper buſineſs. One of theſe he employed in ſilent meditation. He was an admirer of the mathematical ſciences; and was ſo fully convinced of their utility, that when a young man, who was unacquainted with geometry and aſtronomy, deſired admiſſion into the academy, he refuſed his requeſt, ſaying, that he was not yet poſſeſſed of the handles of philoſophy. In fine, Xenocrates was eminent both for the purity of his morals and for his acquaintance with ſcience, and ſupported the credit of the Platonic ſchool, by his lectures, his writings, and his conduct. He lived to the firſt year of the 116th Olympiad, or the 82 of his age, when he loſt his life by accidentally falling, in the dark, into a reſervoir of water.

XENOPHANES, the founder of the Eleaic ſect of philoſophy among the Greeks, was born at Colophon probably about the 65th Olympiad. From ſome cauſe or other he left his country early, and took refuge in Sicily, where he ſupported himſelf by reciting, in the court of Hiero, elegiac and iambic verſes, which he had written in reprehenſion of the theogonies of Heſiod and Homer. From Sicily he paſſed over into Magna Græcia, where he took up the profeſſion of philoſophy, and became a celebrated preceptor in the Pythagorean ſchool. Indulging, however, a greater freedom of thought than was uſual among the diſciples of Pythagoras, he ventured to introduce new opinions of his own, and in many particulars to oppoſe the doctrines of Epimenides, Thales, and Pythagoras. Xenophanes poſſeſſed the Pythagorean chair of philoſophy about ſeventy years, and lived to the extreme age of an hundred years, that is, according to Euſebius, till the 81ſt Olympiad. The doctrine of Xenophanes concerning nature is ſo imperfectly preſerved, and obſcurely expreſſed, that it is no wonder that it has been differently repreſented by different writers. Perhaps the truth is, that he held the univerſe to be one in nature and ſubſtance, but diſtinguiſhed in his conception between the matter of which all things conſiſt, and that latent divine force which, though not a diſtinct ſubſtance but an attribute, is neceſſarily inherent in the univerſe, and is the cauſe of all its perfection.

XENOPHON, an illuſtrious philoſopher, general, and hiſtorian, was born at Athens in the 3d year of the 82d Olympiad. When he was a youth, Socrates, ſtruck with his external appearance, determined to admit him into the number of his pupils. Meeting him by accident in a narrow paſſage, the philoſopher put his ſtaff acroſs the path, and ſtopping him, aſked, where thoſe things were to be purchaſed which are neceſſary to human life? Xenophon appearing at a loſs for a reply to this unexpected ſalutation, Socrates proceeded to aſk him, where honeſt and good men were to be found? Xenophon ſtill heſitating, Socrates ſaid to him, "Follow me, and learn." From that time Xenophon became a diſciple of Socrates, and made a rapid progreſs in that moral wiſdom for which his maſter was ſo eminent. Xenophon accompanied Socrates in the Peloponneſian war, and fought courageouſly in defence of his country. He afterwards entered into the army of Cyrus as a private volunteer in his expedition againſt his brother. This enterpriſe proving unfortunate, Xenophon, after the death of Cyrus, adviſed his fellow ſoldiers to attempt a retreat into their own country. They liſtened to his advice; and having had many proofs of his wiſdom as well as courage, they gave him the command of the army, in the room of Proxenus who had fallen in battle. In this command he acquired great glory by the prudence and firmneſs with which he conducted them back, through the midſt of innumerable dangers, into their own country. The particulars of this memorable adventure are related by Xenophon himſelf in his Retreat of the Ten Thouſand. After his return into Greece, he joined Ageſilaus, king of Sparta, and fought with him againſt the Thebans in the celebrated battle of Chæronea. The Athenians, diſpleaſed at this alliance, brought a public accuſation againſt him for his former conduct in engaging in the ſervice of Cyrus, and condemned him to exile. The Spartans, upon this, took Xenophon, as an injured man, under their protection, and provided him a comfortable retreat at Scilluntes in Elea. Here, with his wife and two children, he remained ſeveral years, and paſſed his time in the ſociety of his friends, and in writing thoſe hiſtorical works which have rendered his name immortal. A war at length aroſe between the Spartans and Eleans; and Xenophon was obliged to retire to Lepreus, where his eldeſt ſon had ſettled. He afterwards removed, with his whole family, to Corinth, where, in the firſt year of the hundred and fifth Olympiad, he finiſhed his days.

XENOPHON the *Younger*, a Greek writer, ſo called to diſtinguiſh him from the celebrated Xenophon, was born at Epheſus, and lived, according to ſome authors, before Heliodorus, that is, about the beginning of the 4th century. He is only known by his *Epheſiaca*, a Greek romance in five books, which is eſteemed, and contains the amours or adventures of Abracomes and Anthia. This romance was printed at London, in Greek and Latin, in 1724, 4to.

XERXES I. the fifth king of Perſia, memorable for the vaſt army he is ſaid to have carried into the field againſt Leonidas king of Sparta; conſiſting, according to ſome hiſtorians, of 800,000 men, while others make it amount to 3,000,000, excluſive of attendants. The fleet that attended this prodigious land force is likewiſe made to conſiſt of 2000 ſail; and all the ſucceſs they met with was the taking and burning the city of Athens; for the army was ſhamefully repulſed near the ſtraits of Thermopylæ by Leonidas, and the fleet was diſperſed and partly deſtroyed by Themiſtocles at the ſtraits of Salamis, who had only 380 ſail under his command. Xerxes was aſſaſſinated by Artabanes, chief captain of his guards, and his diſtinguiſhed favourite. See SPARTA.

XIMENES, FRANCIS, a juſtly celebrated cardinal, biſhop of Toledo, and prime miniſter of Spain, was born at Torrelaguna, in Old Caſtile, in 1437, and ſtudied at Alcala and Salamanca. He then went to Rome; and being robbed on the road, brought nothing back but a bull for obtaining the firſt vacant prebend: but the archbiſhop of Toledo refuſed it him, and threw him into priſon. Being at length reſtored to liberty, he obtained a benefice in the dioceſe of Siguença, where Cardinal Gonzales de Mendoza, who was the biſhop, made him his grand vicar. Ximenes ſome time after entered among the Franciſcans of Toledo; but being there troubled with viſits, he retired to a ſolitude named *Caſtanel*, and applied himſelf to the ſtudy of divinity and the oriental tongues. At his return to Toledo, Queen Iſabella of Caſtile choſe him for her confeſſor, and afterwards nominated him archbiſhop of Toledo; which, next to the papacy, is the richeſt dignity in the church of Rome. "This honour (ſays Dr Robertſon) he declined with a firmneſs which nothing but the authoritative injunction of the pope was able to overcome. Nor did this height of promotion change his manners. Though obliged to diſplay in public that magnificence which became his ſtation, he himſelf retained his monaſtic ſeverity. Under his pontifical robes he conſtantly wore the coarſe frock of St Francis, the rents of which he uſed to patch with his own hands. He at no time uſed linen, but was commonly clad in hair-cloth. He ſlept always in his habit; moſt frequently on the floor or on boards, and rarely in a bed. He did not taſte any of the delicacies which appeared at his table, but ſatisfied himſelf with that ſimple diet which the rule of his order preſcribed. Notwithſtanding theſe peculiarities, ſo oppoſite to the manners of the world, he poſſeſſed a thorough knowledge of its affairs, and diſcovered talents for buſineſs which rendered the fame of his wiſdom equal to that of his ſanctity." His firſt care was to provide for the neceſſities of the poor; to viſit the churches and hoſpitals; to purge his dioceſe of uſurers and places of debauchery; to degrade corrupt judges, and place in their room perſons whom he knew to be diſtinguiſhed by their probity and diſintereſtedneſs. He erected a famous univerſity at Alcala; and in 1499 founded the college of St Ildephonſo. Three years after he undertook the Polyglot Bible; and for that purpoſe ſent for many learned men to come to him at Toledo, purchaſed ſeven copies in Hebrew for 4000 crowns, and gave a great price for Latin and Greek manuſcripts. At this Bible they laboured above 12 years. It contains the Hebrew text of the Bible; the verſion of the Septuagint, with a literal tranſlation; that of St Jerom, and the Chaldee paraphraſes of Onkelos; and Ximenes added to it a dictionary of the Hebrew and Chaldee words contained in the Bible. This work is called *Ximenes's Polyglot.* In 1507 Pope Julius II. gave him the cardinal's hat, and King Ferdinand the Catholic entruſted him with the adminiſtration of affairs. Cardinal Ximenes was from this moment the ſoul of every thing that paſſed in Spain. He diſtinguiſhed himſelf at the beginning of his miniſtry by diſcharging the people from the burdenſome tax called *acavale*, which had been continued on account of the war againſt Granada; and laboured with ſuch zeal and ſucceſs in the converſion of the Mahometans, that he made 3000 converts, among whom was a prince of the blood of the kings of Granada. In 1509 Cardinal Ximenes extended the dominions of Ferdinand, by taking the city of Oran in the kingdom of Algiers. He undertook this conqueſt at his own expence, and marched in perſon at the head of the Spaniſh army clothed in his pontifical ornaments, and accompanied by a great number of eccleſiaſtics and monks. Some time after, foreſeeing an extraordinary ſcarcity, he erected public granaries at Toledo, Alcala, and Torrelaguna, and had them filled with corn at his own expence; which gained the people's hearts to ſuch a degree, that to preſerve the memory of this noble action they had an eulogium upon it cut on marble, in the hall of the ſenate-houſe at Toledo, and in the market-place. King Ferdinand dying in 1516, left Cardinal Ximenes regent of his dominions; and the archduke Charles, who was afterwards the emperor Charles V. confirmed that nomination. The cardinal immediately made a reform of the officers of the ſupreme council and of the court, and put a ſtop to the oppreſſion of the grandees. He vindicated the rights of the people againſt the nobility; and as by the feudal conſtitution the military power was lodged in the hands of the nobles, and men of inferior condition were called into the field only as their vaſſals, a king with ſcanty revenues depended on them in all his operations. From this ſtate Ximenes reſolved to deliver the crown; and iſſued a proclamation, commanding every city in Caſtile to inrol a certain number of its burgeſſes, and teach them military diſcipline; he himſelf engaging to provide officers to command them at the public expence. This was vigorouſly oppoſed by the nobles; but by his intrepidity and ſuperior addreſs he carried his point. He then endeavoured to diminiſh the poſſeſſions of the nobility, by reclaiming all the crown-lands, and putting a ſtop to the penſions granted by the late king Ferdinand. This addition made to the revenues enabled him to diſcharge all the debts of Ferdinand, and to eſtabliſh magazines of warlike ſtores. The nobles, alarmed at theſe repeated attacks, uttered loud complaints; but before they proceeded to extremities, appointed ſome grandees of the firſt rank to examine the powers in conſequence of which he exerciſed acts of ſuch high authority. Ximenes received them with cold civility; produced the teſtament of Ferdinand, by which he was appointed regent, together with the ratification of that deed by Charles. To both theſe they objected; and he endeavoured to eſtabliſh their validity. As the converſation grew warm, he led them inſenſibly to a balcony, from which they had a view of a large body of troops under arms, and of a formidable train of artillery. "Behold (ſays he, pointing to theſe, and raiſing his voice) the powers which I have received from his Catholic majeſty! With theſe I govern Caſtile; and with theſe I will govern it, till the king, your maſter and mine, takes poſſeſſion of his kingdom!" A declaration ſo bold and haughty ſilenced them, and aſtoniſhed their aſſociates. They ſaw that he was prepared for his defence, and laid aſide all thoughts of a general confederacy againſt his adminiſtration. At length, from the repeated intreaties of Ximenes, and the impatient murmurs of the Spaniſh miniſtry, Charles V. embarked, and landed in Spain, accompanied by his favourites. Ximenes was advancing to the coaſt to meet him, but at Bos Equillos was ſeized with a violent diſorder, which his followers conſidered as the effects of poiſon. This accident obliging Ximenes to ſtop, he wrote to the king, and with his uſual boldneſs adviſed him to diſmiſs all the ſtrangers in his train, whoſe number and credit already gave offence to the Spaniards, and earneſtly deſired to have an interview with him, that he might inform him of the ſtate of the nation, and the temper of his ſubjects. To prevent this, not only the Flemings, but the Spaniſh grandees, employed all their addreſs to keep Charles at a diſtance from Aranda, the place to which the cardinal had removed. His advice was now ſlighted and deſpiſed. Ximenes, conſcious of his own integrity and merit, expected a more grateful return from a prince to whom he delivered a kingdom more flouriſhing than it had been in any former age, and a more extenſive authority than the moſt illuſtrious of his anceſtors had ever poſſeſſed; and lamented the fate of his country, about to be ruined by the rapaciouſneſs and inſolence of foreign favourites. While his mind was agitated by theſe paſſions, he received a letter from the king; in which, after a few cold and formal expreſſions of regard, he was allowed to retire to his dioceſe; and he expired a few hours after reading it in 1517, in the 81ſt year of his age.

This famous cardinal ought not to be confounded with *Roderic XIMENES*, archbiſhop of Toledo, in the 13th century, who wrote a Hiſtory of Spain in nine books; nor with ſeveral other Spaniſh writers of the name of *Ximenes*.

XIPHIAS, the SWORD-FISH; a genus of fiſhes belonging to the order of *apodes*. See ICHTHYOLOGY *Index*. This fiſh is common in the Mediterranean ſea, eſpecially in that part which ſeparates Italy from Sicily, and which has been long celebrated for it: the promontory Pelorus, now Capo di Faro, was a place noted for the reſort of the xiphias, and poſſibly the ſtation of the ſpeculatores, or the perſons who watched and gave notice of the approach of the fiſh.

The ancient method of taking them is particularly deſcribed by Strabo, and agrees exactly with that practiſed by the moderns. A man aſcends one of the cliffs that overhangs the ſea: as ſoon as he ſpies the fiſh, he gives notice, either by his voice or by ſigns, of the courſe it takes. Another that is ſtationed in a boat, climbs up the maſt, and on ſeeing the ſword-fiſh, directs the rowers towards it. As ſoon as he thinks they are got within reach, he deſcends, and taking a ſpear in his hand, ſtrikes it into the fiſh; which, after wearying itſelf with its agitation, is ſeized and drawn into the boat. It is much eſteemed by the Sicilians, who buy it up eagerly, and at its firſt coming into ſeaſon give for it about ſixpence Engliſh per pound. The ſeaſon laſts from May till Auguſt. The ancients uſed to cut this fiſh into pieces and ſalt it; whence it was called *Tomus Thurianus*, from Thurii, a town in the bay of Tarentum, where it was taken and cured.

The ſword-fiſh is ſaid to be very voracious, and that it is a great enemy to the tunny, which (according to Belon) are as much terrified at it as ſheep are at the ſight of a wolf. It is a great enemy to whales, and frequently deſtroys them.

XYLO-ALOES, or ALOE WOOD, in the *Materia Medica*, is the product of a tree growing in China and ſome of the Indian iſlands. See EXCÆCARIA.

This drug is diſtinguiſhed into three ſorts; the calambac or tambac, the common lignum aloes, and calambour.

The calambac, or fineſt aloes wood, called by authors *lignum aloes præſtantiſſimum*, and by the Chineſe *ſukhiang*, is the moſt reſinous of all the woods we are acquainted with: it is of a light ſpongy texture, very porous, and its pores ſo filled up with a ſoft and fragrant reſin, that the whole may be preſſed and dented by the fingers like wax, or moulded about by chewing in the mouth, in the manner of maſtich. This kind, laid on the fire, melts in great parts like reſin, and burns away in a few moments with a bright flame and perfumed ſmell. Its ſcent, while in the maſs, is very fragrant and agreeable; and its taſte acrid and bitteriſh, but very aromatic and agreeable. It is ſo variable in its colour, that ſome have divided it into three kinds; the one variegated with black and purple; the ſecond, with the ſame black, but with yellowiſh inſtead of purple; and the third, yellow alone like the yolk of an egg: this laſt is the leaſt ſcented of the three. The variation, however, is owing to the trunk of the tree being itſelf of three different colours; and the heart of it is the valuable ſort firſt deſcribed. The two following are ſuppoſed to be the other parts of the trunk; though this ſeems doubtful, eſpecially in regard to the laſt ſort, from the circumſtance mentioned of its being found in large logs entire, and ſometimes only the *heart*, which, as above noticed, conſtitutes the calambac.

The lignum aloes vulgare is the ſecond in value. This is of a more denſe and compact texture, and conſequently leſs reſinous than the other; there is ſome of it, however, that is ſpongy, and has the holes filled up with the right reſinous matter; and all of it, when good, has veins of the ſame reſin in it. We meet with it in ſmall fragments, which have been cut and ſplit from larger: theſe are of a tolerably denſe texture in the more ſolid pieces, and of a duſky brown colour, variegated with reſinous black veins. It is in this ſtate very heavy, and leſs fragrant than in thoſe pieces which ſhow a multitude of little holes, filled up with the ſame blackiſh matter that forms the veins in others. The woody part of theſe laſt pieces is ſomewhat darker than the other, and is not unfrequently purpliſh, or even blackiſh. The ſmell of the common aloe wood is very agreeable, but not ſo ſtrongly perfumed as the former. Its taſte is ſomewhat bitter and acrid, but very aromatic.

The calambour, called alſo *agallochum ſylveſtre*, and *lignum aloes mexicanum*, is light and friable, of a duſky and often mottled colour, between a duſky green black and a deep brown. Its ſmell is fragrant and agreeable, but much leſs ſweet than that of either of the others; and its taſte bitteriſh, but not ſo much acrid or aromatic as either of the two former. This is ſaid to be met with very frequently, and in large logs; and theſe ſometimes entire, ſometimes only the heart of the tree. This is the aloe wood uſed by the cabinet-makers and inlayers.

This drug is eſteemed a cordial taken inwardly; and is ſometimes given in diſorders of the ſtomach and bowels, and to deſtroy the worms. A very fragrant oil may be procured from it by diſtillation; which is recommended in paralytic caſes from five to fifteen drops. It is at preſent, however, but little uſed; and would ſcarce be met with anywhere in the ſhops, but that it is an ingredient in ſome of the old compoſitions.

XYNOECIA, in Grecian antiquity, an anniverſary feaſt obſerved by the Athenians in honour of Minerva, upon the ſixteenth of Hecatombæon, to commemorate their leaving, bythe perſuaſion of Theſeus, their country ſeats, in which they lay diſperſed here and there in Attica, and uniting together in one body.

XYSTARCHA, in antiquity, the maſter or director of the xyſtus. In the Greek gymnaſium the xyſtarcha was the ſecond officer, and the gymnaſiarcha the firſt; the former was his lieutenant, and preſided over the two xyſti, and all exerciſes of the athletæ therein.

XYSTUS, among the Greeks, was a long portico, open or covered at the top, where the athletæ practiſed wreſtling and running: the gladiators, who practiſed therein, were called *xyſtici*. Among the Romans, the xyſtus was only an alley, or double row of trees, meeting like an arbour, and forming a ſhade to walk under.

Y.

Y, or y, the 23d letter of our alphabet: its ſound is formed by expreſſing the breath with a ſudden expanſion of the lips from that configuration by which we expreſs the vowel *u*. It is one of the ambigenial letters, being a conſonant in the beginning of words, and placed before all vowels, as in *yard*, *yield*, *young*, &c. but before no conſonant. At the end of words it is a vowel, and is ſubſtituted for the ſound of *i*, as in *try*, *deſcry*, &c. In the middle of words it is not uſed ſo frequently as *i* is, unleſs in words derived from the Greek, as in *chyle*, *empyreal*, &c. though it is admitted into the middle of ſome pure Engliſh words, as in *dying*, *flying*, &c. The Romans had no capital of this letter, but uſed the ſmall one in the middle and laſt ſyllables of words, as in *coryambus*, *onyx*, *martyr*. Y is alſo a numeral, ſignifying 150, or, according to Baronius, 159; and with a daſh a-top, as Ȳ, it ſignified 150,000.

YACHT, or YATCH, a veſſel of ſtate, uſually employed to convey princes, ambaſſadors, or other great perſonages, from one kingdom to another.

As the principal deſign of a yacht is to accommodate the paſſengers, it is uſually fitted with a variety of convenient apartments, with ſuitable furniture, according to the quality or number of the perſons contained therein.

The royal yachts are commonly rigged as ketches, except the principal one reſerved for the ſovereign, which is equipped with three maſts like a ſhip. They are in general elegantly furniſhed, and richly ornamented with ſculpture; and always commanded by captains in his majeſty's navy.

Beſides theſe, there are many other yachts of a ſmaller kind, employed by the commiſſioners of the exciſe, navy, and cuſtoms; or uſed as pleaſure-boats by private gentlemen.

YAMS. See DIOSCOREA, } BOTANY *Index*.
YAMBOO. See EUGENIA, }

YARD *of a* SHIP, a long piece of timber ſuſpended upon the maſts of a ſhip, to extend the ſails to the wind. See MAST and SAIL.

All yards are either ſquare or lateen; the former of which are ſuſpended acroſs the maſts at right angles, and the latter obliquely.

The ſquare yards are nearly of a cylindrical ſurface. They taper from the middle, which is called the *ſlings*, towards the extremities, which are termed the *yard-arms*; and the diſtance between the ſlings and the yard-arms on each ſide is by the artificers divided into quarters, which are diſtinguiſhed into the firſt, ſecond, third quarters, and yard-arms. The middle quarters are formed into eight ſquares, and each of the end parts is figured like the fruſtum of a cone. All the yards of a ſhip are ſquare except that of the mizen.

The proportions for the length of yards, according to the different claſſes of ſhips in the Britiſh navy, are as follows:

			Guns.
1000 : gun-deck : :	560 :	main-yard, fig. 1. Pl. CCCCLXVIII. *Note*, the figure repreſents the yard and ſails of a ſhip of 74 guns.	100
	559 :		90 80
	570 :		70
	576 :		60
	575 :		50
	561 :		44
1000 : main-yard : :	880 :	fore-yard.	100 90 80
	874 :		all the reſt.

To apply this rule to practice, ſuppoſe the gun-deck 144 feet. The proportion for this length is, as 1000 is to 575, ſo is 144 to 83; which will be the length of the main-yard in feet, and ſo of all the reſt.

			Guns.
1000 : main-yard : :	820 :	mizen-yard	100 90 80 60 44
	847 :		70
	840 :		24
1000 : main-yard : :	726 :	main topſail-yard	24
	720 :		all the reſt.
1000 : fore-yard : :	719 :	fore topſail-yard	70
	726 :		24
	715 :		all the reſt.
1000 : main topſail-yard : :		main top gallant-yard	all the rates.
1000 fore topſail-yard : :	696 :	fore top gallant-yard.	70
	690 :		all the reſt.
1000 : fore-topſail yard : :	768 :	mizen topſail yard	70
	750 :		all the reſt.

Croſs-jack and ſprit-ſail yards equal to the fore topſail-yard.

Sprit-topſail-yard equal to the fore top-gallant-yard.

The diameters of yards are in the following proportions to their length.

The main and fore yards five-ſevenths of an inch to one yard. The topſail, croſs-jack, and ſprit-ſail yards, nine-fourteenths of an inch to one yard. The top-gallant, mizen topſail, and ſprit-ſail topſail yards, eight-thirteenths of an inch to one yard.

The mizen-yard five-ninths of an inch to one yard.

All ſtudding-ſail booms and yards half an inch to one yard in length.

The lifts of the main-yard are exhibited in the above figure by *g g*; the horſes and their ſtirrups by *h i*; the the reef-tackles and their pendents by *k*, *l*; and the braces and brace-pendents by *m*, *n*.

The lateen-yards evidently derive their names from having been peculiar to the ancient Romans. They are uſually compoſed of ſeveral pieces faſtened together by wooldings, which alſo ſerve as ſteps whereby the ſailors climb to the peek or upper extremity, in order to furl or caſt looſe the ſail.

The mizen-yard of a ſhip, and the main-yard of a bilander, are hung obliquely on the maſt, almoſt in the ſame manner as the lateen-yard of a xebec, ſettee, or polacre.

YARD, a meaſure of length uſed in Britain and Spain, conſiſting of three feet, chiefly to meaſure cloth, ſtuffs, &c.

YARD-*Arm* is that half of the yard that is on either ſide of the maſt, when it lies athwart the ſhip.

YARDS alſo denotes places belonging to the navy, where the ſhips of war, &c. are laid up in harbour.—There are belonging to his majeſty's navy ſix great yards, viz. Chatham, Deptford, Woolwich, Portſmouth, Sheerneſs, and Plymouth; theſe yards are fitted with ſeveral docks, wharfs, launches, and graving places, for the building, repairing, and cleaning of his majeſty's ſhips; and therein are lodged great quantities of timber, maſts, planks, anchors, and other materials: there are alſo convenient ſtore-houſes in each yard, in which are laid up vaſt quantities of cables, rigging, ſails, blocks, and all other ſorts of ſtores needful for the royal navy.

YARE, among ſailors, implies ready or quick: as, be yare at the helm; that is, be quick, ready, and expeditious at the helm. It is ſometimes alſo uſed for bright by ſeamen: as, to keep his arms yare; that is, to keep them clean and bright.

YARE, a river of Norfolk, which runs from weſt to eaſt through that county, paſſing by Norwich, and falling into the German ſea at Yarmouth.

YARMOUTH, a ſea-port town of Norfolk, with a market on Wedneſdays and Saturdays, and a fair on Friday and Saturday in Eaſter-week for petty chapmen. It is ſeated on the river Yare, where it falls into the ſea; and is a place of great ſtrength, both by art and nature, being almoſt ſurrounded with water; and there is a drawbridge over the river. It is eſteemed the key of this coaſt, and is a clean handſome place, whoſe houſes are well built, it being a conſiderable town for trade. It has one large church, and a neat chapel, and the ſteeple of St Nicholas is ſo high that it ſerves for a ſea-mark. It is governed by a mayor. The harbour is a very fine one, though it is very dangerous for ſtrangers in windy weather; and it has for its ſecurity a pretty ſtrong fort. It is 27 miles eaſt of Norwich, and 112 north-eaſt of London. E. Long. 1. 55. N. Lat. 52. 45.

YARMOUTH, a town of the iſle of Wight, in Hampſhire, with a market on Fridays, and one fair on July 25th for toys. It is ſeated on the weſtern part of the iſland, on the ſea-ſhore, and is encompaſſed with water; for, not many years ago a channel was cut through the peninſula, over which there is a drawbridge, and it is defended by a ſtrong caſtle on the quay. It is a handſome place, whoſe houſes are chiefly built with ſtone, and covered with ſlate; and it ſends two members to parliament. The market is now diſuſed. W. Long. 1. 28. N. Lat. 50. 40.

YARN, wool or flax ſpun into thread, of which they weave cloth. See CLOTH.

YARROW. See ACHILLÆA, BOTANY *Index.*

YAWNING, an involuntary opening of the mouth, generally produced by wearineſs or an inclination to ſleep. Yawning, according to Boerhaave, is performed by expanding at one and the ſame time all the muſcles capable of ſpontaneous motion; by greatly extending the lungs; by drawing in gradually and ſlowly a large quantity of air; and gradually and ſlowly breathing it out, after it has been retained for ſome time and rarefied; and then reſtoring the muſcles to their natural ſtate. Hence the effect of yawning is to move, accelerate, and equally diſtribute all the humours through all the veſſels of the body, and conſequently to qualify the muſcles and organs of ſenſation for their various functions.

Sanctorius obſerves, that a great deal is inſenſibly diſcharged, when nature endeavours to get rid of the retained perſpirable matter, by yawning and ſtretching of the limbs. To theſe a perſon is moſt inclined juſt after ſleep, becauſe a greater quantity going off by the pores of the ſkin than at other times, whenſoever a perſon wakes, the increaſing contraction that then happens cloſes a great deal of the perſpirable matter in the cutaneous paſſages, which will continually give ſuch irritations as excite yawning and ſtretching; and ſuch motions, by ſhaking the membranes of the whole body, and ſhifting the contacts of their fibres, and the incloſed matter, by degrees throw it off. Hence we ſee the reaſon why healthful ſtrong people are moſt inclined to ſuch motions, becauſe they perſpire moſt in time of ſleep, and therefore have more of the perſpirable matter to lodge in the pores, and greater irritations thereunto. The advantages of ſome little exerciſe juſt after waking in a morning are conſiderable, as it throws off all the perſpirable matter that is ready for its exit out of the body. When yawning is troubleſome, Hippocrates ſays that long deep reſpiration or drawing in the air at long intervals cures it.

YEAR, in *Aſtronomy* and *Chronology*. See ASTRONOMY and KALENDAR.

The ancient Roman year was the lunar year, which, as firſt ſettled by Romulus, conſiſted of only 10 months; viz. 1. March, containing 31 days. 2. April, 30. 3. May, 31. 4. June, 30. 5. Quintilis, 31. 6. Sextilis, 30. 7. September, 30. 8. October, 31. 9. November, 30. 10. December, 30.—In all 304 days; which came ſhort of the true lunar year by 50 days, and of the ſolar, by 61 days. Numa Pompilius corrected this irregular conſtitution of the year, and compoſed two new months, January and February, of the days that were uſed to be added to the former year.

The ancient Egyptian year, called alſo the *year of Nabonaſſar*, on account of the epoch of Nabonaſſar, is the ſolar year of 365 days, divided into 12 months, of 30 days each, beſides five intercalary days added at the end. The names, &c. of the months are as follows: 1. Thoth. 2. Paophi. 3. Athyr. 4. Chojac. 5. Tybi. 6. Mecheir. 7. Phamenoth. 8. Pharmuthi. 9. Pachon. 10. Pauni. 11. Epiphi. 12. Meſori; beſide the ἡμεραι επαγομεναι.

The ancient Greek year was lunar; conſiſting of 12 months, which at firſt had 30 days apiece, then alternately 30 and 29 days, computed from the firſt appearance of the new moon; with the addition of an emboliſmic month of 30 days, every 3d, 5th, 8th, 11th, 14th, 16th, and 19th year of a cycle of 19 years; in order to keep the new and full moons to the ſame terms or ſeaſons of the year. Their year commenced with that new moon, the full moon of which comes next after the ſummer ſolſtice. The order, &c. of their months was thus: 1. Ἑκατομβαιων, containing 29 days. 2. Μηταγειτνιων, 30. 3. Βοηδρομιων, 29. 4. Μαεμακτηριων, 30. 5. Πυανεψιων, 29. 6. Ποσειδεων. 30. 7. Γαμηλιων, 29. 8. Ανθεστηριων. 30. 9. Ελαφηβολιων, 30. 10. Μουνυχιων, 30. 11. Θαργηλιων, 29. 12. Σκιροφοριων, 30.

The ancient Jewiſh year is a lunar year, conſiſting commonly of 11 months, which alternately contain 30 and 29 days. It was made to agree with the ſolar year, either by the adding of 11, and ſometimes 12 days, at the end of the year, or by an emboliſmic month. The names and quantities of the months ſtand thus: 1. Niſan, or Abib, 30 days. 2. Jiar, or Zius, 29. 3. Siban, or Siwan, 30. 4. Thammuz, or Tammuz, 29. 5. Ab, 30. 6. Elul, 29. 7. Tiſri, or Ethanim, 30. 8. Marcheſvam, or Bul, 29. 9. Ciſleu, 30. 10. Tebeth, 29. 11. Sabat, or Schebeth, 30. 12. Adar, in the emboliſmic year, 30. Adar, in the common year, was but 29. Note, in the defective year, Ciſleu was only 29 days; and in the redundant year, Marcheſvam was 30.

The Perſian year is a ſolar year of about 365 days; conſiſting of 12 months of 30 days each, with five intercalary days added at the end.

The Arabic, Mahometan, and Turkiſh years, called alſo the *year of the Hegira*, is a lunar year, equal to 354 days eight hours and 48 minutes, and conſiſts of 12 months, which contain alternately 30 and 29 days.

The Hindoo year differs from all theſe, and is indeed different in different provinces of India. The beſt account that we have of it is by Mr Cavendiſh, in the Phil. Tranſ. of the Royal Society of London for the year 1792. "Before I ſpeak of the civil year of the Hindoos (ſays this eminent philoſopher), it will be proper to ſay a few words of the aſtronomical year, by which it is regulated.

"The aſtronomical year begins at the inſtant when the ſun comes to the firſt point of the Hindoo zodiac. In the year 1792, it began on April 9th, at 22h. 14′ after midnight of their firſt meridian, which is about 41′ of time weſt of Calcutta; but, according to Mr Gentil's account of the Indian aſtronomy, it began 3h. 24′ earlier. As this year, however, is longer than ours, its commencement falls continually later, in reſpect of the Julian year, by 50′ 26″ in four years. This year is divided into 12 months, each of which correſponds to the time of the ſun's ſtay in ſome ſign; ſo that they are of different lengths, and ſeldom begin at the beginning of a day.

"The civil day in all parts of India begins at ſunriſe, and is divided into 60 parts called *dandas*, which are again divided into 60 palas. In thoſe parts of India in which the Benares almanac, or as it is there called *patras*, is uſed, the civil year is luniſolar, conſiſting of 12 lunar months, with an intercalary month inſerted between them occaſionally. It begins at the day after the new moon next before the beginning of the ſolar year. The lunar month is divided into 30 parts called *teethees;* theſe are not ſtrictly of the ſame length, but are equal to the time in which the moon's true motion from the ſun is 12°. From the new moon till the moon arrives at 12° diſtance from the ſun is called the firſt *teethee;* from thence till it comes to 24°, is called the ſecond *teethee;* and ſo on till the full moon, after which the teethees return in the ſame order as before.

"The civil day is conſtantly called by the number of that teethee which expires during the courſe of the day; and as the teethee is ſometimes longer than one day, a day ſometimes occurs in which no teethee ends. When this is the caſe, the day is called by the ſame number as the following day; ſo that two ſucceſſive days go by the ſame name. It oftener happens, however, that two teethees end on the ſame day; in which caſe the number of the firſt of them gives name to the day, and there is no day called by the number of the laſt, ſo that a gap is made in the order of the days. In the latter part of the month the days are counted from the full moon, in the ſame manner as in the former part they are counted from the new moon; only the laſt day, or that on which the new moon happens, is called the 30th, inſtead of the 15th. It appears, therefore, that each half of the month conſtantly begins on the day after that on which the new or full moon falls; only ſometimes the half month begins with the ſecond day, the firſt being wanting.

"This manner of counting the days is ſufficiently intricate; but that of counting the months is ſtill more ſo.

"The civil year, as was before ſaid, begins at the day after the new moon; and, moreover, in the years which have an intercalary month, this month begins at the day after the new moon; but notwithſtanding this, the ordinary civil month begins at the day after the full moon. To make their method more intelligible, we will call the time from new moon to new moon the natural month. The civil month Viſakha, the firſt in the Hindoo kalender, which extends from the 9th of our April to the 10th of May, begins at the day after that full moon which is neareſt to the inſtant at which the ſun enters Meſha, the firſt in order of the Indian ſigns, whether before or after; however, it is not always accurately the neareſt.

"A conſequence of this way of counting the months is, that the firſt half of Chitra, the laſt month in the Indian kalender, extending from March the 10th to April the 9th, falls in one year, and the latter half in the following year; and whenever the ſun enters no ſign during a natural month, this month is intercalary. The number of days in the month varies from 29 to 32. Indeed the Hindoo months, both ſolar and lunar, conſiſt neither of a determinate number of days, nor are regulated by any cycle, but depend ſolely on the motions of the ſun and moon; ſo that a Hindoo has no way of knowing what day of the month it is but by conſulting his almanac; and what is more, the month ought ſometimes to begin on different days, in different places, on account of the difference in latitude and longitude, not to mention the difference which may ariſe from errors in computation. This mode of computing time muſt be attended with many inconveniences; but in the tranſactions of civil life the Hindoos do not much regard it. A diſagreement, however, in the computation of the teethee, which ſometimes alſo happens, occaſions no ſmall perplexity; becauſe by the teethees or lunar days are regulated moſt of their religious feſtivals. Every Brahmin in charge of a temple, or whoſe duty it is to announce the times for the obſervance of religious ceremonies, is therefore furniſhed with one of their almanacs; and if he be an aſtronomer, he makes ſuch corrections in it as the difference of latitude and longitude renders neceſſary."

New YEAR's Gift. See GIFT.

YEAST, or YEST, a head or ſcum riſing upon beer or ale while working or fermenting in the vat. See BREWING.

It is uſed for a leaven or ferment in the baking of bread, as ſerving to ſwell or puff it up very conſiderably in a little time, and to make it much lighter, ſofter, and more delicate. See BAKING, BARM, and BREAD.

Mr Henry has publiſhed a method of preparing *artificial yeaſt*, by which good bread may be made without the aſſiſtance of any other ferment. The method is this: Boil flour and water together to the conſiſtence of treacle, and when the mixture is cold ſaturate it with fixed air. Pour the mixture thus ſaturated into one or more large bottles or narrow-mouthed jars; cover it over looſely with paper, and upon that lay a ſlate or board with a weight to keep it ſteady. Place the veſſel in a ſituation where the thermometer will ſtand from 70° to 80°, and ſtir up the mixture two or three times in 24 hours. In about two days ſuch a degree of fermentation will have taken place, as to give the mixture the appearance of yeaſt. With the yeaſt in this ſtate, and before it has acquired a thoroughly vinous ſmell, mix the quantity of flour intended for bread, in the proportion of ſix pounds of flour to a quart of the yeaſt, and a ſufficient portion of warm water. Knead them well together in a proper veſſel, and covering it with a cloth, let the dough ſtand for 12 hours, or till it appears to be ſufficiently fermented in the fore-mentioned degree of warmth. It is then to be formed into loaves and baked. Mr Henry adds, that perhaps the yeaſt would be more perfect, if a decoction of malt were uſed inſtead of ſimple water.

It has lately been diſcovered, that a decoction of malt alone, without any addition, will produce a yeaſt proper enough for the purpoſe of brewing. This diſcovery was made by Joſeph Senyor, ſervant of the reverend Mr Maſon of Aſton near Rotheram; and he received for it a reward of 20l. from the Society for promoting Arts, Manufactures, and Commerce. The proceſs is as follows: Procure three earthen or wooden veſſels of different ſizes and apertures, one capable of holding two quarts, the other three or four, and the third five or ſix: boil a quarter of a peck of malt for about eight or ten minutes in three pints of water; and when a quart is poured off from the grains, let it ſtand in the firſt or ſmaller veſſel in a cool place till not quite cold, but retaining that degree of heat which the brewers uſually find to be proper when they begin to work their liquor. Then remove the veſſel into ſome warm ſituation near a fire, where the thermometer ſtands between 70 and 80 degrees Fahrenheit, and there let it remain till the fermentation begins, which will be plainly perceived within 30 hours: add then two quarts more of a like decoction of malt, when cool, as the firſt was; and mix the whole in the ſecond or larger veſſel, and ſtir it well in, which muſt be repeated in the uſual way, as it riſes in a common vat: then add a ſtill greater quantity of the ſame decoction, to be worked in the largeſt veſſel, which will produce yeaſt enough for a brewing of 40 gallons.

Common ale yeaſt may be kept freſh and fit for uſe ſeveral months by the following method: Put a quantity of it into a cloſe canvas bag, and gently ſqueeze out the moiſture in a ſcrew-preſs till the remaining matter be as firm and ſtiff as clay. In this ſtate it may be cloſe packed up in a tight caſk for ſecuring it from the air; and will keep freſh, ſound, and fit for uſe, for a long time. This is a ſecret that might be of great uſe to the brewers and diſtillers, who, though they employ very large quantities of yeaſt, ſeem to know no method of preſerving it, or raiſing nurſeries of it; for want of which they ſuſtain a very conſiderable loſs; whereas the brewers in Flanders make a very great advantage of ſupplying the malt diſtillers of Holland with yeaſt, which is rendered laſting and fit for carriage by this eaſy expedient.

YELL, one of the iſlands of Shetland, lying north-eaſt from the Mainland, and divided from it by an arm of the ſea, called *Yell-Sound*. By ſome it is thought to have been the *Thule* of the ancients. In the old deſcriptions it is ſaid to be 20 miles long and 8 broad. It is very mountainous and full of moſs; but there are pretty conſiderable paſtures in which they feed a great many ſheep; and it alſo affords plenty of peat. It has eight large harbours, which would not be though deſpicable in other countries. Anciently it ſeems to have been pretty populous, ſince there are in it three churches, twenty chapels, and many brughs or Pictiſh forts.

YELLOW, one of the original colours of light.

YELLOW-Colour for Houſe-painting. See *COLOUR-Making*.

Naples YELLOW, a beautiful colour much uſed by painters, formerly thought to be prepared from arſenic, but now diſcovered to have lead for its baſis.

YELLOW-Hammer. See FRINGILLA, ORNITHOLOGY *Index*.

YELLOW-Fever. See MEDICINE, N° 168.

YEMEN, a province of Arabia, ſtretching along the Red ſea and Indian ocean, and forming a part of the country once known by the name of Arabia Felix.

YEOMAN, the firſt or higheſt degree among the plebeians of England, next in order to the gentry.

The yeomen are properly freeholders, who having land of their own, live on good huſbandry.

YEOMAN is alſo a title of office in the king's houſehold, of a middle place or rank between an uſher and a groom.

YEOMEN of the Guard were anciently 250 men of the beſt rank under gentry, and of larger ſtature than ordinary, each being required to be ſix feet high. At preſent there are but 100 yeomen in conſtant duty, and 70 more not in duty; and as any of the 100 dies, his place is ſupplied out of the 70. They go dreſſed after the manner of King Henry VIII.'s time. They formerly had diet as well as wages when in waiting; but this was taken off in the reign of Queen Anne.

YEST, or YEAST. See YEAST.

YEW. See TAXUS, BOTANY *Index*.

Yew trees are remarkable for their duration. There are now growing within 300 yards of the old Gothic ruins of Fountain's abbey, near Rippon, in Yorkſhire, ſeven very large yew trees, commonly called the Seven Siſters, whoſe exact ages cannot be accurately aſcertained, though tradition ſays that they were ſtanding in the year 1088. It is ſaid alſo, that when the great Fountain's abbey was building, which is 700 feet long, and was finiſhed in 1283, the maſons uſed to work their ſtones, during the hot ſummers, under the ſhade of theſe trees. The circumference of the Seven Siſters, when meaſured by a curious traveller, were of the following ſizes:—the ſmalleſt tree, round its body, 5 yards 1 foot; four others are from $5\frac{1}{2}$ to $7\frac{1}{2}$ yards; the ſixth is $9\frac{1}{2}$ yards; and the ſeventh is 11 yards 1 foot 7 inches in circumference, being 2 yards 10 inches larger than the

great

great yew tree now growing in the churchyard at Greſford, in North Wales, which is 9 yards 9 inches. Theſe trees are the largeſt and oldeſt in the Britiſh dominions.

YNCA, an appellation anciently given to the kings of Peru, and the princes of their blood; the word literally ſignifying, lord, king, emperor, and royal blood.

YOAK, or YOKE, in *Agriculture*, a frame of wood fitted over the necks of oxen, whereby they are coupled together, and harneſſed to the plough.

YOAK of Land, in our ancient cuſtoms, was the ſpace which a yoke of oxen, that is, two oxen, may plough in one day.

YOLK, the yellow part in the middle of an egg (ſee EGG). It contains a lymphatic ſubſtance mixed with a certain quantity of mild oil, which, on account of this mixture, is ſoluble in water. When expoſed to heat, it aſſumes a conſiſtence not ſo hard as the white of the egg; and when bruiſed gives out the oil which it contains. This oil has been uſed externally as a liniment.

YONNE, a river in France, which riſing in Burgundy, and running north through Nivernois and Champagne, falls into the Seine at Monterau ſur Yonne.

YORK, in Latin *Eboracum*, the capital of Yorkſhire in England. This city is ſo ancient that the origin of it is uncertain. In the time of the Romans a legion was ſtationed here, it being then the capital of the Brigantes; and here died the emperor Severus, and Flavius Valerius Conſtantius Chlorus, father of Conſtantine the Great. There was then alſo a temple of Bellona here, and no leſs than three military ways went from hence. In the time of the Saxons it was erected into an archbiſhopric by Pope Honorius, to which are now ſubject the biſhoprics of Cheſter, Durham, Carliſle, and the iſle of Man; though anciently 12 biſhoprics in England, and all Scotland, were. A horn is ſtill kept in the minſter, by which Ulphius, one of the Saxon princes, beſtowed all his lands and revenues upon the church.

This city ſuffered very much during the ravages of the Danes; but, after the Conqueſt, it began to flouriſh again. The cathedral, which coſt a long time and a great deal of money in building, is a moſt ſtately Gothic pile. Its chapter-houſe is particularly admired for its painted glaſs, its fine marble ſtalls, its pillars of alabaſter, and curious contrivance. In it is the following line in gold letters:

Ut Roſa, flos florum, ſic eſt Domus iſta Domorum.

The choir is remarkable for its fine carvings, particularly the ſtatues of all the Engliſh monarchs; and the windows are exquiſitely painted with the hiſtory of the Bible. The lanthorn ſteeple is 70 feet ſquare, and 188 high, and the windows are 45. At the ſouth end is a circular light, called the *marigold window* from the colour of its glaſs; and at the north end is a very large one, whoſe painting repreſents embroidery.

This city is generally reckoned the ſecond city in England; but though it ſtands upon more ground, it is inferior in trade, wealth, and number of people, to Briſtol. The inhabitants are reckoned at 16,145. It is ſituated in a fine plain, in the middle of the ſhire, on both ſides the Ouſe, walled and divided into four wards, containing 28 pariſhes. It enjoys large privileges and immunities, conferred upon it by a ſucceſſion of kings from Henry II. and its chief magiſtrate has the title of *lord mayor*, which is an honour peculiar to it and London. Richard II. made it a county of itſelf. The conſervancy of moſt of the rivers of the county, within certain limits, belongs to the lord mayor and aldermen. The middle arch of the bridge here over the Ouſe is thought to equal the Rialto at Venice in architecture, height, and breadth, the diameter being 81 feet, and the height 51. Though this city is 60 miles diſtant from the ſea, yet ſhips of 70 tons burden come up the river to it. The town-houſe or guild-hall ſtands upon the bridge, and is ſuperior in all reſpects to that of London. In the Popiſh times there were nine abbeys here, and a vaſt number of churches; but of the latter there are only 17 now. The ſteeple of that of Allhallows is reckoned the fineſt in England. The archbiſhop has a fine palace; and the aſſembly-room, deſigned by the earl of Burlington, is very noble. Here are plays, aſſemblies, concerts, and the like entertainments, at ſome houſe or other, almoſt every night in the week. In the old caſtle, built originally by William the Conqueror, and repaired in 1701, the aſſizes are kept. It ſerves alſo for the county-gaol, which is the neateſt and pleaſanteſt in England, with an area larger than that of the King's-bench, and it has a handſome chapel in it, with a good allowance for a preacher. This city has long given the title of *duke* to ſome branch of the royal family.

The plenty and cheapneſs of proviſions induces many perſons of ſmall fortune, or that would live frugally, to take up their abode here; and the venerable remains of Roman antiquities, and thoſe of a later date, as abbeys, churches, and caſtles, procure this city a viſit from every curious traveller. Many Roman altars, urns, coins, inſcriptions, &c. have been found; and Saxon coins are ſtill extant that have been ſtruck here. The members, being two in number, for this city, have precedence of all others, except thoſe of London, in the houſe of commons. An infirmary, after the manner of thoſe of Bath, Briſtol, &c. hath been erected in it; and a cotton manufacture eſtabliſhed and brought to great perfection. Beſides four weekly markets, it has a great many fairs; one, in particular, every other Thurſday for cattle and ſheep. W. Long. 1. 1. N. Lat. 53. 59.

YORKSHIRE, the largeſt county of England, bounded on the ſouth by Derbyſhire, Nottinghamſhire, and Lincolnſhire; on the north by Durham and Weſtmoreland; on the eaſt by the German ocean; and on the weſt by Lancaſhire and a part of Cheſhire.—It is upwards of 80 miles in length from eaſt to weſt, nearly as much in breadth, and about 360 in circumference, containing, in the whole, 26 hundreds or wapentakes, 49 market-towns, 563 pariſhes, 242 vicarages, with many chapels of eaſe, and 2330 villages. Its area is computed by ſome at 4684 ſquare miles, by others at 3,770,000 acres, and its inhabitants at 858,892. It is divided into three parts or ridings, viz. the Weſt, Eaſt, and North; ſo denominated from their ſituation, in reſpect of the city of York. Each of theſe is as large, if not larger, than any ordinary county. There are other diviſions, as Richmondſhire, Allertonſhire, Howdenſhire, Hallanſhire, Craven, Cleveland, Marſhland, Holderneſs, &c.

As the ſoil and face of the country vary greatly, ſo does the air. In the hilly parts the air is good, but the ſoil very indifferent; of the lower ſome are marſhy, others drier, and the ſoil of both rich; but the air of the former is more foggy and unhealthy than that of the latter. The manufactures of this county are cutlery and hard-wares; particularly knives, bits, and ſpurs; but the principal are ſtockings and woollen cloth, with which it ſupplies in a great meaſure Germany and the North. As to the produce, it abounds in corn, cattle, horſes, lead, and iron, coal, wood, lime, liquorice, alum, jet, &c. It lies wholly in the northern circuit, and much the greater part of it in the dioceſe of York; that only which is called *Richmondſhire* belonging to the dioceſe of Cheſter. The members it ſends to parliament are 30; of which two are for the ſhire and 28 for the towns.

New-YORK, one of the United States of America, is bounded towards the ſouth-eaſt by the Atlantic ocean; eaſt by Connecticut, Maſſachuſets, and Vermont; north by the 45th degree of latitude, which divides it from Canada; northweſtwardly by the river Irequois or St Lawrence, and the lakes Ontario and Erie; ſouthweſt and ſouth by Pennſylvania and New Jerſey. The whole ſtate contains about 44,000 ſquare miles, equal to 28,160,000 acres.

The ſettlements already made in this ſtate are chiefly upon two narrow oblongs, extending from the city of New York eaſt and north. The one eaſt is Long iſland, which is 140 miles long, and narrow, and ſurrounded by the ſea. The one extending north is about 40 miles in breadth, and biſected by Hudſon's river. And ſuch is the interſection of the whole ſtate by the branches of the Hudſon, the Delaware, the Suſquehannah, and other large rivers, that there are few places throughout its whole extent which are more than 15 or 20 miles from ſome navigable ſtream. There are few fiſh in the rivers, but in the brooks are plenty of trout; and in the lakes yellow perch, ſun-fiſh, ſalmon-trout, cat-fiſh, and a variety of others.

The State, to ſpeak generally, abounds with lakes, ſome of ſalt and others of freſh water. It is interſected by ridges of mountains running in a north-eaſt and ſouth-weſt direction. Beyond the Allegany mountains, however, the country is a dead level, of a fine rich ſoil, covered, in its natural ſtate, with maple, beach, birch, cherry, black-walnut, locuſt, hickory, and ſome mulberry trees. On the banks of lake Erie are a few cheſnut and oak ridges. Hemlock ſwamps are interſperſed thinly through the country. All the creeks that empty into lake Erie have falls, which afford many excellent mill ſeats. Eaſt of the Allegany mountains, the country is broken into hills with rich intervening valleys. The hills are clothed thick with timber, and when cleared afford fine paſture; the valleys, when cultivated, produce wheat, hemp, flax, peaſe, graſs, oats, Indian corn. Of the commodities produced from culture, wheat is the ſtaple; of which immenſe quantities are raiſed and exported. Indian corn and peaſe are likewiſe raiſed for exportation; and rye, oats, barley, &c. for home conſumption. In ſome parts of the State excellent dairies are kept, which furniſh for the market butter and cheeſe.

The ſituation of New-York, with reſpect to foreign markets, has decidedly the preference to any other of the United States. It has at all ſeaſons of the year a ſhort and eaſy acceſs to the ocean. Its exports to the Weſt Indies are, biſcuit, peaſe, Indian corn apples, onions, boards, ſtaves, horſes, ſheep, butter, cheeſe, pickled oyſters, beef, and pork. But wheat is the ſtaple commodity of the State, of which no leſs than 677,700 buſhels were exported in the year 1775, beſides 2555 tons of bread and 2828 tons of flour. Inſpectors of flour are appointed to prevent impoſition, and to ſee that none is exported but that which is deemed by them merchantable. Beſides the above-mentioned articles, are exported flax-ſeed, cotton, wool, ſarſaparilla, coffee, indigo, rice, pig-iron, bar-iron, pot-aſh, pearl-aſh, furs, deer-ſkins, logwood, fuſtick, mahogany, bees wax, oil, Madeira wine, rum, tar, pitch, turpentine, whale-fins, fiſh, ſugars, molaſſes, ſalt, tobacco, lard, &c. but moſt of theſe articles are imported for re-exportation. In the year 1774, there were employed, in the trade of this State, 1075 veſſels, whoſe tonnage amounted to 40,812.

Since the revolution, the literature of the State has engaged the attention of the legiſlature. In one of their earlieſt ſeſſions an act paſſed, conſtituting 21 gentlemen (of whom the governor and lieutenant-governor for the time being are members *ex officiis*) a body coporate and politic, by the name and ſtyle of "The regents of the univerſity of the State of New-York." They are intruſted with the care of literature in general in the State, and have power to grant charters of incorporation for erecting colleges and academies throughout the ſtate—are to viſit theſe inſtitutions as often as they ſhall think proper, and report their ſtate to the legiſlature once a-year. All degrees above that of maſter of arts are to be conferred by the regents. A univerſal toleration is granted in religion.

The ſupreme legiſlative powers of the State are veſted in two branches, a ſenate and aſſembly. The members of the ſenate are elected by the freeholders of the State, who poſſeſs freehold eſtates to the value of 100l. clear of debts. For the purpoſe of electing ſenators, the State is divided into four great diſtricts, each of which chooſes a certain number.

The aſſembly of the State is compoſed of repreſentatives from the ſeveral counties, choſen annually in May. Every male inhabitant of full age, who has reſided in the ſtate ſix months preceding the day of election, and poſſeſſing a freehold to the value of 20l. in the county where he is to give his vote; or has rented a tenement therein of the yearly value of forty ſhillings, and has been rated and actually paid taxes—is entitled to vote for repreſentatives in aſſembly. The number of repreſentatives is limited to 300.

The ſupreme executive power of the ſtate is veſted in a governor choſen once in three years by the freemen of the ſtate. The lieutenant-governor is, by his office, preſident of the ſenate; and, upon an equal diviſion of voices, has a caſting vote; but has no voice on other occaſions. The governor has not a ſeat in the legiſlature; but as a member of the council of reviſion and council of appointment, he has a vaſt influence in the ſtate. The council of reviſion is compoſed of the chancellor, the judges of the ſupreme court, or any of them, and the governor. In the year 1790 the number of inhabitants in this ſtate was 340,120, of whom 21,324 were negroes; but in 1795 the whole population of the ſtate amounted to 530,177, making an increaſe of 190,057 in five years.

New-YORK, a city of North America, capital of the ſtate of the ſame name. It is ſituated at the ſouth-weſt

York.

point of an iſland, at the confluence of Hudſon and Eaſt rivers, and is about four miles in circumference. The ſituation is both healthy and pleaſant. Surrounded on all ſides by water, it is refreſhed by cool breezes in ſummer, and the air in winter is more temperate than in other places under the ſame parallel. York iſland is 15 miles in length, and hardly one in breadth. It is joined to the main by a bridge called King's bridge. The channels between Long and Staten iſlands, and between Long and York iſlands, are ſo narrow as to occaſion an unuſual rapidity of the tides, which is increaſed by the confluence of the waters of Hudſon and Eaſt rivers. This rapidity, in general, prevents the obſtruction of the channel by ice. There is no baſon or bay for the reception of ſhips; but the road where they lie in Eaſt river is defended from the violence of the ſea by the iſlands which interlock with each other; ſo that, except that of Rhode iſland, the harbour of New-York, which admits ſhips of any burden, is the beſt of the United States. The number of the inhabitants in 1786 was 23,614.

The moſt magnificent edifice in this city is *Federal Hall*, at the head of Broad-ſtreet; in a gallery in front of which General Waſhington, attended by the ſenate and houſe of repreſentatives, took his oath of office at the commencement of the operation of the federal conſtitution, 30th April, 1789. The other public buildings in the city are, three houſes for public worſhip for the Dutch Reformed church, four for Preſbyterians, three for Epiſcopalians, two for German Lutherans and Calviniſts, two for Quakers, two for Baptiſts, two for Methodiſts, one for Moravians, one for Catholics, one for French Proteſtants, and a Jewiſh ſynagogue.

King's college was chiefly founded by the voluntary contributions of the inhabitants of the province, aſſiſted by the general aſſembly, and the corporation of Trinity Church; in the year 1754, a royal charter (and grant of money) being then obtained, incorporating a number of gentlemen therein mentioned, by the name of "The Governors of the College of the Province of New-York, in the city of New-York, in America;" granting to them the power of conferring all ſuch degrees as are uſually conferred by either of the Engliſh univerſities. The building conſiſts of an elegant ſtone edifice, three ſtories high, with four ſtair caſes, 12 apartments in each, a chapel, hall, library, muſeum, anatomical theatre, and a ſchool for experimental philoſophy. It is ſituated on a dry gravelly ſoil, about 150 yards from the bank of Hudſon's river, commanding a beautiful and extenſive proſpect. Since the revolution, the legiſlature paſſed an act conſtituting 21 gentlemen (of whom the governor and lieutenant-governor for the time being, are members *ex officiis*) a body corporate and politic by the name of "The Regents of the Univerſity of the State of New-York." They are entruſted with the care of literature in general, and have power to grant charters for erecting colleges and academies through the ſtate. It is now denominated *Columbia college*. The annual revenue ariſing from the eſtate belonging to the college amounts to 1535l. currency, excluſive of ſome bonds which are not as yet productive. It conſiſts of a faculty of arts, and one of phyſic, the firſt having a preſident and ſeven profeſſors, and the ſecond a dean, and the ſame number of profeſſors. The library and muſeum were deſtroyed during the war, after which upwards of 800l. were expended on books to enlarge the library.

York, Young.

The government of this city is at preſent in the hands of a mayor, aldermen, and common council, and the city is divided into ſeven wards, in each of which an alderman and aſſiſtant are annually choſen by the people. A court of ſeſſion is held for the trial of criminal cauſes. It is eſteemed the moſt eligible ſituation for commerce in the United States; but the want of good water is a great inconveniency, there being few wells in the city, and moſt of the people are ſupplied with freſh water conveyed to their doors in caſks from the head of Queen ſtreet. The number of inhabitants in 1796 is ſtated at more than 33,000; and according to ſome it is ſuppoſed that they amount at this time to nearly the double. The entries from foreign ports in 1795, were 178 ſhips, 309 brigs, 9 barques, 7 ſnows, 268 ſchooners, and 170 ſloops. Works of defence have been erected to a conſiderable extent, and when completed on the original plan, will afford great ſecurity to the city. New-York is 95 miles N. E. of Philadelphia, 197 N. E. of Baltimore, and 913 from Charleſton. W. Long. 74° 9′ 45″. N. Lat. 40° 42′ 8″.

YOUNG, Dr Edward, was the ſon of a clergyman of the ſame name, and was born about the year 1679. When ſufficiently qualified, he was matriculated into All-Souls college, Oxford; and deſigning to follow the civil law, he took a degree in that profeſſion. In this ſituation he wrote his poem called The Laſt Day, publiſhed in 1704; which coming from a layman gave univerſal ſatisfaction: this was ſoon after followed by another, entitled The Force of Religion, or Vanquiſhed Love. Theſe productions gained him a reſpectable acquaintance; he was intimate with Addiſon, and thus became one of the writers of the Spectator: but the turn of his mind leading him to the church, he took orders, was made one of the king's chaplains, and obtained the living of Welwyn in Hartfordſhire, worth about 500l. per annum, but he never roſe to higher preferment. For ſome years before the death of the late prince of Wales, Dr Young attended his court pretty conſtantly; but upon his deceaſe all his hopes of church preferment vaniſhed; however, upon the death of Dr Hales, he was taken into the ſervice of the princeſs-dowager of Wales, and ſucceeded him as her privy chaplain. When pretty far advanced in life, he married the lady Elizabeth Lee, daughter of the late earl of Litchfield. This lady was a widow, and had an amiable ſon and daughter, who both died young. What he felt for their loſs, as well as for that of his wife, is finely expreſſed in his Night Thoughts, in which the young lady is characteriſed under the name of Narciſſa; her brother by that of Philander; and his wife, though nameleſs, is frequently mentioned; and he thus, in an apoſtrophe to death, deplores the loſs of all the three.

> Inſatiate archer, could not once ſuffice!
> Thy ſhaft flew thrice, and thrice my peace was ſlain,
> And thrice ere thrice yon moon renew'd her horn.

He wrote three tragedies, The Revenge, Buſiris, and The Brothers. His ſatires, called Love of Fame the univerſal Paſſion, are by many eſteemed his principal performance; though Swift ſaid the poet ſhould have been

Young.

been either more angry or more merry: they have been characteriſed as a ſtring of epigrams written on one ſubject, that tire the reader before he gets through them. His Complaint, or Night Thoughts, exhibit him as a moral and melancholy poet, and are eſteemed his maſterpiece. They form a ſpecies of poetry peculiarly his own, and in which he has been unrivalled by all thoſe who attempted to write in this manner. They were written under the recent preſſure of his ſorrow for the loſs of his wife, daughter, and ſon-in-law; they are addreſſed to Lorenzo, a man of pleaſure and the world, and who, as it is inſinuated by ſome, is his own ſon, but then labouring under his father's diſpleaſure. As a proſe-writer, he arraigned the prevailing manners of his time, in a work called The Centaur not Fabulous; and when he was above 80 years of age, publiſhed Conjectures on Original Compoſition. He publiſhed ſome other pieces; and the whole of his works are collected in 4 and 5 vols 12mo. Dr Young's turn of mind was naturally ſolemn; and he uſually, when at home in the country, ſpent many hours of the day walking in his own church-yard among the tombs. His converſation, his writings, had all a reference to the life after this; and this turn of diſpoſition mixed itſelf even with his improvements in gardening. He had, for inſtance, an alcove with a bench, ſo painted, near his houſe, that at a diſtance it looked as a real one which the ſpectator was then approaching. Upon coming up near it, however, the deception was perceived, and this motto appeared, *Inviſibilia non decipiunt*, "The things unſeen do not deceive us." Yet, notwithſtanding this gloomineſs of temper, he was fond of innocent ſports and amuſement: he inſtituted an aſſembly and a bowling-green in the pariſh of which he was rector, and often promoted the gaiety of the company in perſon. His wit was generally poignant, and ever levelled at thoſe who teſtified any contempt for decency and religion. His epigram, ſpoken extempore on Voltaire, is well known; who happening in his company to ridicule Milton, and the allegorical perſonages of Death and Sin, Young thus addreſſed him:

Thou art ſo witty, profligate, and thin,
You ſeem a Milton with his Death and Sin.

Young
||
Yunx.

One Sunday, preaching in office at St James's, he found, that though he ſtrove to make his audience attentive, he could not prevail. Upon which his pity for their folly got the better of all decorums, and he ſat back in the pulpit and burſt into a flood of tears. Towards the latter part of life he knew his own infirmities, and ſuffered himſelf to be in pupilage to his houſe-keeper; for he conſidered that, at a certain time of life, the ſecond childhood of age demanded its wonted protection. His ſon, whoſe boyiſh follies were long obnoxious to paternal ſeverity, was at laſt forgiven in his will; and our poet died regretted by all, having performed all that man could do to fill his poſt with dignity. His death happened in 1765.

YOUTH, that ſtate of man in which he approaches towards his greateſt perfection of body.

YPRES, a handſome, large, and populous town of the Auſtrian Netherlands, with a biſhop's ſee. It has a conſiderable manufactory in cloth and ſerges, and every year in Lent there is a conſiderable fair. It is one of the barrier towns, but was beſieged and taken by the French in 1744, and alſo in 1794. It is ſeated in a fertile plain on the river Ypre, in E. Long. 2. 48. N. Lat. 50. 51.

YTTRIA, one of the lately diſcovered earths. For an account of its properties and combinations ſee CHEMISTRY, N° 1457.

Yttrio-Tantalite, a mineral ſubſtance containing the new earth yttria, and the new metal tantalium, which latter is found by Dr Wollaſton to be identical with columbium.

YUCCA, ADAM'S NEEDLE, a genus of plants of the claſs hexandria. The ſpecies of this plant are all exceedingly curious in their growth, and are therefore much cultivated in gardens. The Indians make a kind of bread from the roots of this plant.

YULE, YOOL, or *Iul*. See IUL.

YUNX, a genus of birds of the order *picæ*. See ORNITHOLOGY *Index*.

Z.

Z.

Z, or z, the 24th and laſt letter, and the 19th conſonant of our alphabet; the ſound of which is formed by a motion of the tongue from the palate downwards and upwards to it again, with a ſhutting and opening of the teeth at the ſame time. This letter has been reputed a double conſonant, having the ſound *ds*; but ſome think with very little reaſon: and, as if we thought otherwiſe, we often double it, as in *puzzle*, *muzzle*, &c. Among the ancients, Z was a numeral letter, ſignifying 2000; and with a daſh added a-top, $\bar{Z}$ ſignified 2000 times 2000, or 4,000,000.

In abbreviations this letter formerly ſtood as a mark for ſeveral ſorts of weights; ſometimes it ſignified an ounce and a half; and very frequently it ſtood for half an ounce; ſometimes for the eighth part of an ounce, or a dram troy weight; and it has in earlier times been uſed to expreſs the third part of an ounce or eight ſcruples. ZZ were uſed by ſome of the ancient phyſicians to expreſs myrrh, and at preſent they are often uſed to ſignify zinziber or ginger.

Z,
Zaara.

ZAARA, ZAPARA, SAHARA, or *the Deſert*, a vaſt country of Africa, bounded on the north by Barbary, on the eaſt by Fezzan and Caſhna, on the ſouth by Tombuctoo, and on the weſt by the Atlantic ocean. Zaara contains a variety of wandering nations, all proceeding from Arabs, Moors, and fugitive Portugueſe, who took refuge there when the family of the Sherifs made themſelves maſters of the three kingdoms of Barbary.

bary. All theſe people bear indiſcriminately the names of *Nars*, *Moors*, or *Arabs*. They are ſubdivided into various nations, of which the moſt conſiderable are the Mongearts, Traſars, and Bracnars. The Mongearts lead a wandering life, and live chiefly on the milk of their flocks, with a little barley-meal, and ſome dates. The poorer ſort go naked, except the females, who commonly wrap a clout about their middle, and wear a kind of bonnet on their head; but the wealthier ſort have a kind of looſe gown, made of blue calico, with large ſleeves, that is brought them from Negroland. When they move from one place to another for freſh paſture, water, or prey, moſt of them ride on camels, which have generally a ſort of ſaddle between the bunch and the neck, with a ſtring or ſtrap run through their noſtrils, which ſerves for a bridle; and inſtead of ſpurs they uſe a ſharp bodkin. Their tents or huts are covered with a coarſe ſtuff, made of camel's hair, and a kind of wool or moſs that grows on the palm trees. Theſe Arabs live here under the government of their ſheiks or cheyks; as in Arabia, Egypt, and other places. The other two tribes are rather more civilized. They are all Mahometans.

ZABULON, in *Ancient Geography*, one of the twelve tribes; bounded on the north by the tribes of Aſher and Naphthali; on the eaſt by the ſea of Galilee; on the ſouth by the tribe of Iſſachar or the brook Ciſon, which ran between both; on the weſt by the Mediterranean; ſo that it touched two ſeas, or was bimarous.

Zabulon, in *Ancient Geography*, a very ſtrong town in the tribe of that name, on the Mediterranean, ſirnamed *of men*, near Ptolemais: its vicinity to which makes it probable that it was alſo Chabulon, unleſs either name is a faulty reading in Joſephus; diſtant about 60 ſtadia from Ptolemais.

ZACYNTHUS, in *Ancient Geography*, an iſland to the ſouth of Cephalenia 60 ſtadia, but nearer to Peloponneſus, in the Ionian ſea, formerly ſubject to Ulyſſes, in compaſs above 160 ſtadia, woody and fruitful, with a conſiderable cognominal town and a port. The iſland lies over againſt Elis, having a colony of Achæans from Peloponneſus, over againſt the Corinthian gulf. Both iſland and town are now called *Zante*.

ZAFFRE, is the oxide of cobalt, employed for painting pottery ware and porcelain of a blue colour. The method of preparing it is as follows: The cobalt taken out of the mine is broken with hammers into pieces about the ſize of a hen's egg; and the ſtony involucrum, with ſuch other heterogeneous matters as are diſtinguiſhable by the eye, are ſeparated as much as poſſible. The choſen mineral is then pounded in ſtamping mills, and ſifted through braſs wire ſieves. The lighter parts are waſhed off by water, and it is afterwards put into a large flat-bottomed arched furnace, reſembling a baking oven, where the flame of the wood reverberates upon the ore; which is occaſionally ſtirred and turned with long handled iron hooks or rakes; and the proceſs is continued till it ceaſes to emit any fumes. The oven or furnace is terminated by a long horizontal gallery, which ſerves for a chimney; in which the arſenic, naturally mixed with the ore, ſublimes. If the ore contains a little biſmuth, as this ſemimetal is very fuſible, it is collected at the bottom of the furnace. The cobalt remains in the ſtate of a dark gray oxide, and is called *zaffre*. One hundred pounds of the cobalt ore loſe 20 and even 30 per cent. during this operation, which is continued 4 or even 9 hours, according to the quality of the ore. The roaſted ore being taken out from the furnace, ſuch parts as are concreted into lumps are pounded and ſifted afreſh. Zaffre, in commerce, is never pure, being mixed with two or rather three parts of powdered flints. A proper quantity of the beſt ſort of theſe, after being ignited in a furnace, is thrown into water to render it friable, and more eaſily reduced to powder; which, being ſifted, is mixed with the zaffre, according to the before-mentioned doſe; and the mixture is put into caſks, after being moiſtened with water. This oxide, fuſed with three parts of ſand and one of potaſh, forms a blue glaſs; which, when pounded, ſifted, and afterwards ground in mills, included in large caſks, forms *ſmalt*.

The blue of zaffre is the moſt ſolid and fixed of all the colours that can be employed in vitrification. It ſuffers no change from the moſt violent fire. It is ſucceſsfully employed to give ſhades of blue to enamels, and to the cryſtal-glaſſes made in imitation of ſome opaque and tranſparent precious ſtones, as the lapis lazuli, the turquois, the ſapphire, and others of this kind.

ZALEUCUS, a famous legiſlator of the Locrians, and the diſciple of Pythagoras, flouriſhed 500 years B. C. He made a law, by which he puniſhed adulterers with the loſs of both their eyes; and his ſon offending, was not abſolved from this puniſhment: yet, to ſhow the father as well as the juſt lawgiver, he put out his own right, and his ſon's left eye. This example of juſtice and ſeverity made ſo ſtrong an impreſſion on the minds of his ſubjects, that no inſtance was found of the commiſſion of that vice during the reign of that legiſlator. It is added, that Zaleucus forbade any wine being given to the ſick on pain of death, unleſs it was preſcribed by the phyſicians; and that he was ſo jealous of his laws, that he ordered, that whoever was deſirous of changing them, ſhould be obliged, when he made the propoſal, to have a cord about his neck, in order that he might be immediately ſtrangled, if thoſe alterations were eſteemed no better than the laws already eſtabliſhed. Diodorus Siculus attributes the ſame thing to Charondas legiſlator of the Sybarites.

ZAMA, in *Ancient Geography*, a town of Chamane, a diſtrict of Cappadocia, of unknown ſituation.—Another Zama, of Meſopotamia, on the Saocoras, to the ſouth of Niſibis.—A third, of Numidia, diſtant five days journey to the weſt of Carthage: it was the other royal reſidence of the kings of Numidia, hence called *Zama Regia*. It ſtood in a plain; was ſtronger by art than nature; richly ſupplied with every neceſſary; and abounding in men, and every weapon both of defence and annoyance.

The laſt of theſe is remarkable for the deciſive battle fought between the two greateſt commanders in the world, Hannibal the Carthaginian and Scipio Africanus. Of this engagement, the moſt important perhaps that ever was fought, Mr Hooke gives the following account.

"Scipio drew up his army after the Roman manner, except that he placed the cohorts of the Principes directly behind thoſe of the Haſtati, ſo as to leave ſufficient ſpace for the enemy's elephants to paſs through from front to rear. C. Lælius was poſted on the left wing with the Italian horſe, and Maſiniſſa with his Numidians on the right. The intervals of the firſt line Scipio filled up with his Velites, or light-armed troops, ordering them, upon a ſignal given, to begin the battle; and in caſe they were repulſed, or broke by the elephants, to run back through the lanes before mentioned, and continue on their flight till they were got behind the Triarii. Thoſe that were wounded, or in danger of being overtaken, were to turn off to the right and left through the ſpaces between the lines, and that way eſcape to the rear.

" The army thus drawn up, Scipio went from rank to rank, urging his ſoldiers to conſider the conſequences of a defeat and the rewards of victory: on the one hand, certain death or ſlavery (for they had no town in Africa ſtrong enough to protect them); on the other, not only a laſting ſuperiority over Carthage, but the empire of the reſt of the world.

" Hannibal ranged all his elephants, to the number of above 80, in one front. Behind theſe he placed his mercenaries, conſiſting of 12,000 men, Ligurians, Gauls, Baleares, and Mauritanians.

" The new levies of Carthaginians and other Africans, together with 4000 Macedonians, under a general named *Sopater*, compoſed the ſecond line. And in the rear of all, at the diſtance of about a furlong, he poſted his Italian troops, in whom he chiefly confided. The Carthaginian horſe formed his right wing, the Numidians his left.

" He ordered their ſeveral leaders to exhort their troops not to be diſcouraged by their own weakneſs, but to place the hope of victory in him and his Italian army; and particularly directed the captains of the Carthaginians to repreſent to them what would be the fate of their wives and children if the event of this battle ſhould not prove ſucceſsful. The general himſelf, walking through the ranks of his Italian troops, called upon them to be mindful of the 17 campaigns in which they had been fellow-ſoldiers with him; and of that conſtant ſeries of victories by which they had extinguiſhed in the Romans all hope of ever being conquerors. He urged them to remember, above all, the battles of Trebia, Thraſymenus, and Cannæ; with any of which the approaching battle was in no wiſe to be compared, either with reſpect to the bravery or the number of the enemy. ' The Romans were yet unfoiled, and in the height of their ſtrength, when you firſt met them in the field; nevertheleſs you vanquiſhed them. The ſoldiers now before us are either the children of the vanquiſhed, or the remains of thoſe whom you have often put to flight in Italy. Maintain therefore your general's glory and your own, and eſtabliſh to yourſelves the name of invincible, by which you are become famous throughout the world.'

" When the Numidians of the two armies had ſkirmiſhed a while, Hannibal ordered the managers of the elephants to drive them upon the enemy. Some of the beaſts, frightened at the noiſe of the trumpets and other inſtruments of war which ſounded on all ſides, immediately ran back amongſt the Numidians of the Carthaginian left wing, and put them into confuſion; which Maſiniſſa taking advantage of, entirely routed them. Great deſtruction was made of the Velites by the reſt of the elephants, till theſe alſo being terrified, ſome of them ran through the void ſpaces of the Roman army which Scipio had left for that purpoſe; others falling in among the cavalry of the enemy's right wing, gave Lælius the ſame opportunity againſt the Carthaginian horſe as had been given to Maſiniſſa againſt the Numidian, and of which the Roman did not fail to make the ſame uſe. After this the infantry of the foremoſt lines joined battle. Hannibal's mercenaries had the advantage in the beginning of the conflict; but the Roman Haſtati, followed and encouraged by the Principes, who exhorted them to fight manfully, and ſhowed themſelves ready to aſſiſt them, bravely ſuſtained the attack, and at length gained ground upon the enemy. The mercenaries not being ſeaſonably ſupported by their ſecond line, and therefore thinking themſelves betrayed, they in their retreat fell furiouſly upon the Africans; ſo that theſe, the Haſtati coming up, were obliged to fight for ſome time both againſt their own mercenaries and the enemy. When the two Carthaginian lines had ceaſed their mutual rage, they joined their ſtrength; and though now but a mere throng of men, broke the Haſtati: but then the Principes advancing to the aſſiſtance of the latter, reſtored the battle; and moſt of the Africans and mercenaries were here cut off. Hannibal did not advance to their relief, the Roman Triarii not having yet engaged, and the Principes being ſtill in good order; and leſt the routed Africans and mercenaries ſhould break the ranks of his Italian ſoldiers, he commanded theſe to preſent their ſpears at thoſe who fled to them for protection, which obliged the runaways to move off to the right and left.

" The ground over which the Romans muſt march before they could attack Hannibal being ſtrewed with heaps of dead bodies and weapons, and being ſlippery with blood, Scipio feared that the order of his battalions would be broke, ſhould he paſs it haſtily. To avoid this miſchief, he commanded the Haſtati to give over the purſuit, and halt where they were, oppoſite to the enemy's centre: after which, having ſent all his wounded to the rear, he advanced leiſurely with the Principes and Triarii, and placed them on the wings of the Haſtati. Then followed a ſharp engagement, in which victory was long and eagerly diſputed. It would ſeem that the Romans, though ſuperior in number, were once upon the point of loſing the day; for Polybius tells us, that Maſiniſſa and Lælius came very ſeaſonably, and as if ſent from heaven, to their aſſiſtance. Theſe generals being returned from the purſuit of the cavalry, fell ſuddenly upon the rear of Hannibal's men, moſt of whom were cut off in their ranks; and of thoſe that fled, very few eſcaped the horſe, the country all around being a plain.

" There died of the Carthaginians in the fight above 20,000, and almoſt the like number were taken priſoners. The loſs on the ſide of the Romans amounted to about 2000 men. Hannibal eſcaped with a few horſe to Adrumetum, having performed every thing in the engagement which could be expected from a great general. His army (ſays Polybius) could not have been more ſkilfully drawn up. For as the order of the Roman battalions makes it extremely difficult to break them, the Carthaginian wiſely placed his elephants in the front, that they might put the enemy in confuſion before the armies ſhould engage. In his firſt line he placed the mercenaries; men bold and active, but not

well

well diſciplined, that by their impetuoſity he might give a check to the ardour of the Romans. The Africans and Carthaginians, whoſe courage he doubted, he poſted in the middle between the mercenaries and his Italian ſoldiers, that they might be forced to fight, or at leaſt that the Romans, by ſlaughtering them, might fatigue themſelves and blunt their weapons. Laſt of all, he drew up the troops he had diſciplined himſelf, and in whom he chiefly confided, at a good diſtance from the ſecond line, that they might not be broken by the route of the Africans and mercenaries, and kept them in reſerve for a vigorous attack upon a tired and weakened enemy."

ZANGUEBAR, a country in Africa, lying on the eaſtern coaſt, between three degrees of north latitude, and 18 ſouth. It includes ſeveral petty kingdoms, in which the Portugueſe have various ſettlements. The inhabitants, except thoſe converted by the Portugueſe, are all Mahometans or idolaters ; and the latter much the more numerous. The names of the principal territories are *Mombaza*, *Lamon*, *Melinda*, *Quiola*, and *Moſambique*. The Portugueſe have built ſeveral forts in Mombaza and Moſambique, and have ſettled ſeveral colonies there. They trade with the negroes for ſlaves, ivory, gold, oſtrich-feathers, wax, and drugs. The productions are much the ſame as in other parts of Africa between the tropics.

ZANONIA, a genus of plants of the claſs pentandria. See BOTANY *Index*.

ZANTE, an iſland of the Mediterranean, near the coaſt of the Morea, 19 miles ſouth-eaſt of the iſland of Cephalonia, belonging to the Venetians. It is about 24 miles in length and 12 in breadth, and very pleaſant and fertile ; but its principal riches conſiſt in currants, with which it greatly abounds. They are cultivated in a very large plain, under the ſhelter of mountains on the ſhore of this iſland ; for which reaſon the ſun has greater power to bring them to perfect maturity. The town called *Zante* may contain near 20,000 inhabitants ; the whole iſland contains about 40,000. The houſes are low, on account of the frequent earthquakes, for ſcarce a year paſſes without one ; however, they do no great damage. The natives ſpeak both Greek and Italian. There are very few Roman Catholics among them ; but they have a biſhop as well as the Greeks. This place has no fortifications, but there is a fortreſs upon an eminence planted with cannon. In one part of this iſland is a place which ſhakes when trod upon like a quagmire ; and a ſpring which throws out a great deal of bitumen, eſpecially at the time of an earthquake. It ſerves inſtead of pitch to pay the bottoms of the ſhips, and about 100 barrels in a year are uſed for this purpoſe. There are about 50 villages in the iſland ; but no other large town beſide Zante. It is ſeated on the eaſtern ſide of the iſland, and has a good harbour. The Engliſh and Dutch have each a factory and conſul here. E. Long. 21. 3. N. Lat. 37. 53.

ZANTHOXYLUM, the TOOTHACHE-TREE, a genus of plants of the claſs of diœcia ; and in the natural ſyſtem arranged under the 46th order, *Hederaceæ*. See BOTANY *Index*.

ZAPATA, a kind of feaſt or ceremony held in Italy in the courts of certain princes, on St Nicholas's day ; wherein people hide preſents in the ſhoes or ſlippers of thoſe they would do honour to, in ſuch a manner as may ſurpriſe them on the morrow when they come to dreſs ; being done in imitation of the practice of St Nicholas, who uſed in the night-time to throw purſes of money in at the windows to marry poor maids withal.

ZEA, INDIAN CORN ; a genus of plants of the claſs monœcia. See BOTANY *Index*.—There is only one ſpecies, the *Mays*, maize. The Indians in New England, and many other parts of America, had no other vegetable but maize or Indian corn for making their bread. They call it *weachin* ; and in the United States of America there is much of the bread of the country made of this grain, not of the European corn. In Italy and Germany alſo there is a ſpecies of maize which is the food of the poor inhabitants.

The ear of the maize yields a much greater quantity of grain than any of our corn ears. There are commonly about eight rows of grain in the ear, often more, if the ground be good. Each of theſe rows contains at leaſt 30 grains, and each of theſe gives much more flour than a grain of any of our corn. The grains are uſually either white or yellowiſh ; but ſometimes they are red, bluiſh, greeniſh, or olive-coloured, and ſometimes ſtriped and variegated. This ſort of grain, though ſo eſſentially neceſſary to the natives of the place, is yet liable to many accidents. It does not ripen till the end of September ; ſo that the rains often fall heavy upon it while on the ſtalk, and the birds in general peck it when it is ſoft and unripe. Nature has, to defend it from theſe accidents, covered it with a thick huſk, which keeps off ſlight rains very well : but the birds, if not frighted away, often eat through it, and devour a great quantity of the grain.

There are three or four varieties of maize in different parts of America. That of Virginia is very tall and robuſt, growing to ſeven or eight feet high ; that of New England is ſhorter and lower. And the Indians farther up in the country have a yet ſmaller kind in common uſe. The ſtalk of the maize is jointed like the ſugar-cane ; it is very ſoft and juicy, and the juice is ſo ſweet and ſaccharine, that a ſyrup, as ſweet as that of ſugar, has been often made of it ; and things ſweetened with it have been found not diſtinguiſhable from thoſe done with ſugar. It has not been tried yet whether it will cryſtallize into ſugar ; but in all probability it will.

The Americans plant this corn any time from the beginning of March to the beginning of June ; but the beſt ſeaſon is the middle of April. The ſavage Indians, who knew nothing of our account of months, uſed to guide themſelves in the ſeed-time of this uſeful plant by the budding of ſome particular trees of that country, and by the coming up of a ſort of fiſh into their rivers which they call the *aloofe*. Theſe things were both ſo regular, that they were in no danger of miſtaking the time.

The manner of planting maize is in rows, at equal diſtances, every way about five or ſix feet. They open the earth with a hoe, taking away the ſurface to three or four inches deep, and of the breadth of the hoe ; they then throw in a little of the finer earth, ſo as to leave the hoe four inches deep or thereabouts, and in each of theſe holes they place four or five grains at a little diſtance from one another. If two or three of theſe grow up, it is very well ; ſome of them are uſually deſtroyed either by the birds or other animals.

When

When the young plants appear, they hoe up the weeds from time to time; and when the ſtalk gathers ſome ſtrength, they raiſe the earth a little about it, and continue this at every hoeing till it begins to put forth the ears; then they enlarge the hill of earth, round the root, to the ſize of a hop-hill, and after this they leave it till the time of harveſt, without any farther care. When they gather the ears, they either immediately ſtrip off the corn, or elſe hang up the ears, tied in traces at diſtances from one another; for if they are laid near together, they will heat and rot or elſe ſprout and grow; but kept cool and ſeparate, they will remain good all the winter. The beſt method is to thraſh out the corn as ſoon as the harveſt is over, to dry it well on mats in the ſun, and then lay it up in holes of the ground, well lined with mats, graſs, or the like, and afterwards covered at top with more earth. The moſt careful among the Indians uſe this method, and this ſort of ſubterranean granary always proves good.

The uſes of this plant among the Indians are very many. The great article is the making their bread of it; but beſides this, the ſtalks, when cut up before they are too much dried, are an excellent winter food for cattle; but they uſually leave them on the ground for the cattle to feed on. The huſks about the ear are uſually ſeparated from the reſt, and make a particular ſort of fodder, not inferior to our hay. The Indian women have a way of ſlitting them into narrow parts, and they then weave them artificially into baſkets and many other toys. The original way of eating the grain among the Indians was this: they boiled it whole in water till it ſwelled and became tender, and then they fed on it either alone or ate it with their fiſh and veniſon inſtead of bread. After this, they found the way of boiling it into a ſort of pudding, after bruiſing it in a mortar; but the way of reducing it to flour is the beſt of all. They do this by parching it carefully in the fire, without burning, and then beating it in mortars and ſifting it. This flour they lay up in bags as their conſtant proviſion, and take it out with them when they go to war, eating it either dry or with water. The Engliſh have contrived, by mixing it into a ſtiff paſte, either by itſelf or with rye or wheat-meal, fermenting it with leaven or yeaſt, and baking it in a hot oven, to make good bread of it. They have likewiſe found out a method of making good beer, either of the bread or by malting the grain.

ZEAL, paſſionate ardour for any perſon or cauſe. It is moſt frequently uſed to denote a ſtrong and warm attachment to the diſtinguiſhing doctrines or worſhip of ſome particular ſect of Chriſtians. Thus we ſay, a zealous *Calviniſt*, *Arminian*, or *Papiſt;* though we may likewiſe with the greateſt propriety ſay of an upright and benevolent man, that he is zealous of *good works*.

ZEALAND, the chief of the Daniſh iſlands, is ſituated at the entrance of the Baltic ſea, bounded by the Schaggerrac ſea on the north; by the Sound, which ſeparates it from Schonen, on the eaſt; by the Baltic ſea on the ſouth; and by the ſtrait called the *Great Belt*, which ſeparates it from the iſland of Funen, on the weſt; being of a round figure, near 200 miles in circumference: the chief town is Copenhagen.

Zealand, is alſo a province of the United Netherlands, conſiſting of eight iſlands, which lie in the mouth of the river Scheldt, bounded by the province of Holland, from which they are ſeparated by a narrow channel on the north; by Brabant on the eaſt; by Flanders, from which they are ſeparated by one of the branches of the Scheldt, on the ſouth; and by the German ocean on the weſt.

New ZEALAND, a country of Aſia, in the South Pacific ocean, firſt diſcovered by Taſman, the Dutch navigator, in the year 1642, who gave it the name of *Staten Land*, though it has been generally diſtinguiſhed in our maps and charts by the name of *New Zealand*, and was ſuppoſed to be part of a ſouthern continent: but it is now known, from the late diſcoveries of Captain Cook who ſailed round it, to conſiſt of two large iſlands, divided from each other by a ſtrait four or five leagues broad. They are ſituated between the latitudes of 34 and 48 degrees ſouth, and between the longitudes of 166 and 180 degrees eaſt from Greenwich. One of theſe iſlands is for the moſt part mountainous, rather barren, and but thinly inhabited; but the other is much more fertile, and of a better appearance. In the opinion of Sir Joſeph Banks and Dr Solander, every kind of European fruits, grain, and plants, would flouriſh here in the utmoſt luxuriance. From the vegetables found here, it is ſuppoſed that the winters are milder than thoſe in England, and the ſummers not hotter, though more equally warm; ſo that it is imagined, that if this country were ſettled by people from Europe, they would, with moderate induſtry, be ſoon ſupplied, not only with the neceſſaries, but the luxuries of life, in great abundance. Here are foreſts of vaſt extent, filled with very large timber trees; and near 400 plants were found here that had not been deſcribed by the naturaliſts. The inhabitants of New Zealand are ſtout and robuſt, and equal in ſtature to the largeſt Europeans. Their colour in general is brown, but in few deeper than that of the Spaniard who has been expoſed to the ſun, and in many not ſo deep; and both ſexes have good features. Their dreſs is very uncouth, and they mark their bodies in a manner ſimilar to the inhabitants of Otaheite, and which is called *tattowing*. Their principal weapons are lances, darts, and a kind of battle-axes; and they have generally ſhown themſelves very hoſtile to the Europeans who have viſited them.

ZEALOTS, an ancient ſect of the Jews, ſo called from their pretended zeal for God's law and the honour of religion.

ZEBRA. See Equus, Mammalia *Index*.

ZEBU, a name given by M. de Buffon to the bos indicus of Linnæus. See Mammalia *Index*.

ZECHARIAH, a canonical book of the Old Teſtament. See Scripture, N° 80.

ZECHIN, or Zecchino. See Sequin.

ZEDOARY, in the *Materia Medica*. See Kæmpferia.

ZELL, a city of Germany in the circle of Lower Saxony, capital of the duchies of Zell and Lunenburg, ſituated at the confluence of the rivers Aller and Fuhſe, 30 miles north of Hanover, and 40 ſouth of Lunenburg. E. Long. 10. 12. N. Lat. 52. 49.

ZEMBLA, Nova, a very large iſland, lying in the Northern ocean, to the north of Ruſſia, from which it is ſeparated by the ſtrait of Waigate. It has no inhabitants except wild beaſts, particularly white foxes and bears. In 1595 a Dutch veſſel was caſt away on the coaſt, and the ſhip's company were obliged to winter here; but they did not ſee the ſun from the fourth of November to the beginning of February, and had great difficulty to keep themſelves from being frozen to death.

ZEMINDAR, in its original meaning, ſignifies a great landholder of Bengal; but it is now more ſtrictly applicable to thoſe who have their title conſtituted or confirmed by a patent or charter from government, by which they hold their lands or zemindaries upon certain conditions. It appears from hiſtory, that, in times prior to the irruption of the Mahomedans, the rajahs who held their reſidence at Delhy, and poſſeſſed the ſovereignty of Hindoſtan, deputed officers to collect their revenues. The word *zemindar* is Perſian, and that language can have had no currency in the countries of India, until it was introduced by the people of Perſia. When the emperor Shehab-ul-Dien Ghory conquered the empire of Hindoſtan at the end of the 12th century, he left Sultan Cutub-ul-Dien to be his viceroy at Delhy, and adminiſter the government of Hindoſtan. From that time the cuſtoms and practices of the Mahomedans began gradually to be eſtabliſhed in India: their armies were ſent into the countries of the reduced rajahs, under the command of omrahs, in order to preſerve the conqueſt; and lands were allotted to them to defray the expence. From hence aroſe the ſyſtem of Jaghiredarry in Hindoſtan. But when theſe Omrah Jaghiredars had eſtabliſhed their own ſtrength, ſeveral of them rebelled againſt the imperial authority, and aſpired at the crown. Thus circumſtanced, the emperors, in order to obviate theſe miſchiefs, thought it would be more politic to commit the management of the country to the native Hindoos, who had moſt diſtinguiſhed themſelves by the readineſs and conſtancy of their obedience to the ſovereign power.

In purſuance of this plan, diſtricts were allotted to numbers of them under a reaſonable revenue (Jummah Monâſib), which they were required to pay in money to the governors of the provinces, deputed from the emperor. And in caſe any one of the omrahs or provincial governors ſhould ſwerve from his allegiance, the zemindars of that country were to exert themſelves in ſuch a manner as ſhould check rebellion, and reſtore good government. For this purpoſe, grants of zemindary were ſeverally conferred upon ſuch of the Hindoos as were obedient; deſcribing their apportionment of the country; and every perſon who had received a grant under the authority of the crown was thereby fully inveſted with the functions of zemindar.

The functions of a zemindar are, 1ſt, The preſervation and defence of their reſpective boundaries from traitors and inſurgents. 2dly, The tranquillity of the ſubjects, the abundance of cultivators, and increaſe of his revenue. 3dly, The puniſhment of thieves and robbers, the prevention of crimes, and the deſtruction of highwaymen. The accompliſhment of theſe objects is conſidered in the royal grant as the diſcharge of office to the ſovereign; and on that account the word *office* (khidmut) is employed in the Dewanny Sunnud for a zemindary.

It was a rule in the times of the ancient emperors, that when any of the zemindars died, their effects and property were ſequeſtrated by the government. After which, in conſideration of the rights of long ſervice, which is incumbent on ſovereigns, and elevates the dignity of the employer, ſunnuds for the office of zemindary were granted to the children of the deceaſed zemindar; and no other perſon was accepted, becauſe the inhabitants could never feel for any ſtranger the attachment and affection which they naturally entertain for the family of their zemindar, and would have been afflicted if any other had been put over them. For this reaſon, the emperors, conſidering it as a means of conciliating the minds of the people, graciouſly fixed and confirmed the children of the deceaſed zemindar in the office of their fathers and grandfathers, by iſſuing new ſunnuds to transfer the poſſeſſion to them. By degrees zemindaries became truly heritable property, which, however, could be transferred by gift or ſale from one family to another. They could likewiſe be forfeited to the ſovereign, by the zemindar's deviating from his allegiance, neglecting to pay his tribute, or to diſcharge the duties of his ſtation.

It is univerſally known, ſays Sir Charles Rouſe Boughton, that, when the three provinces of Bengal, Bahar, and Oriſſa, were ceded to the Britiſh Eaſt India Company, the country was diſtributed among the zemindars and talookdars or holders of land, who paid a ſtipulated revenue, by twelve inſtalments, to the ſovereign power or its delegates. They aſſembled at the capital in the beginning of every Bengal year (commencing in April), in order to complete their final payments, and make up their annual accounts; to ſettle the diſcount to be charged upon their ſeveral remittances in various coins for the purpoſe of reducing them to one ſtandard, or adjuſt their concerns with their bankers; to petition for remiſſions on account of ſtorms, drought, inundation, diſturbances, and ſuch like; to make their repreſentations of the ſtate and occurrences of their diſtricts: after all which they entered upon the collections of the new year; of which, however, they were not permitted to begin receiving the rents from their own farmers, till they had completely cloſed the accounts of the preceding year, ſo that they might not encroach upon the new rents, to make up the deficiency of the paſt. Our author proves, we think completely, the right of the zemindars to transfer their poſſeſſions, either by inheritance to their children, or, with the conſent of the ſovereign, to other families; and he argues ſtrenuouſly and ſucceſsfully againſt the bad policy, as well as injuſtice, of interfering with thoſe rights, as long as the zemindars diſcharge the duties of their ſeveral ſtations.

ZEND, or ZENDAVESTA, a book aſcribed to Zoroaſter, and containing his pretended revelations; which the ancient Magicians and modern Perſees, called alſo *Gaurs*, obſerve and reverence in the ſame manner as the Chriſtians do the Bible, and the Mahometans the Koran, making it the ſole rule both of their faith and manners. The word, it is ſaid, originally ſignifies any inſtrument for kindling fire, and is applied to this book to denote its aptitude for kindling the flame of religion in the hearts of thoſe who read it.

The Zend contains a reformed ſyſtem of Magianiſm; teaching that there is a Supreme Being, eternal, ſelf-exiſtent, and independent, who created both light and darkneſs, out of which he made all other things; that theſe are in a ſtate of conflict, which will continue till the end of the world; that then there ſhall be a general reſurrection and judgement; and that juſt retribution ſhall be rendered unto men according to their works; that the angel of darkneſs with his followers ſhall be conſigned to a place of everlaſting darkneſs and puniſhment, and the angel of light with his diſciples introduced into a ſtate of everlaſting light and happineſs; after which light and darkneſs ſhall no more interfere with each other. The Zend alſo enjoins the conſtant maintenance of ſacred fires and fire temples for religious worſhip; the diſtinction of clean and unclean beaſts; the payment of tithes to prieſts, which are to be of one family or tribe; a multitude of waſhings and purifications, reſembling thoſe of the Jewiſh law; and a variety of rules and exhortations for the exerciſe of benevolence and charity.

In this book there are many paſſages evidently taken out of the Scriptures of the Old Teſtament, particularly out of the Pſalms of David: The author repreſents Adam and Eve as the firſt parents of all mankind, gives in ſubſtance the ſame account of the creation and deluge with Moſes, differing indeed with regard to the former, by converting the ſix days of the Moſaic account into ſix times, comprehending in the whole 365 days; and ſpeaks alſo of Abraham, Joſeph, Moſes, and Solomon. Moreover, Dr Baumgarten aſſerts, that this work contains doctrines, opinions, and facts, actually borrowed from the Jews, Chriſtians, and Mahometans; whence, and from other circumſtances, he concludes that both the hiſtory and writings of this prophet were probably invented in the later ages, when the fire-worſhippers under the Mahometan government thought fit to vindicate their religion from the ſuſpicion of idolatry.

At whatever period the Zend may have been written, we are aſſured by Dr Hyde, that it is in the pure old Perſian language, and in the character called *Peplavi.* Some parts of it contain the original next, and others Zoroaſter's ſecond thoughts ſubjoined, for explaining more fully his doctrine. Theſe were occaſioned by the oppoſition of adverſaries, and unforeſeen circumſtances which occurred during the fabrication of the impoſture. About 300 years ago, when the old Perſian language had become antiquated and little underſtood, one of the deſtours or high-prieſts among the Perſees compoſed the *Sadda*, which is a compendium in the vulgar or modern Perſic tongue, of thoſe parts of the Zend that relate to religion, or a kind of code of canons and precepts, drawn from the theological writings of Zoroaſter, ſerving as an authoritative rule of faith and practice for his followers. This Sadda is written in a low kind of Perſic verſe, and as Dr Hyde informs us, it is *bonorum et malorum farrago*, having many good and pious things, and others very ſuperſtitious and trifling. See Persees and Zoroaster.

ZENITH, in *Aſtronomy*, the vertical point, or a point in the heavens directly over our heads.

Enfield's Hiſtory of Philoſophy.

ZENO Eleates, an eminent Grecian philoſopher, was born at Elea about 504 years before Chriſt. He was a zealous friend of civil liberty, and is celebrated for his courageous and ſucceſsful oppoſition to tyrants; but the inconſiſtency of the ſtories related by different writers concerning him in a great meaſure deſtroys their credit. He choſe to reſide in his ſmall native city of Elea rather than at Athens, becauſe it afforded freer ſcope to his independent and generous ſpirit, which could not eaſily ſubmit to the reſtraints of authority. It is related, that he vindicated the warmth with which he reſented reproach, by ſaying, "If I were indifferent to cenſure, I ſhould alſo be indifferent to praiſe." The invention of the dialectic art has been improperly aſcribed to Zeno; but there can be no doubt that this philoſopher, and other metaphyſical diſputants in the Eleatic ſect, employed much ingenuity and ſubtlety in exhibiting examples of moſt of the logical arts, which were afterwards reduced to rule by Ariſtotle and others.

According to Ariſtotle, he taught, that nothing can be produced either from that which is ſimilar or diſſimilar; that there is only one being, God; who is eternal, homogeneous, and ſpherical, neither finite nor infinite, neither quieſcent nor moveable; that there are many worlds; that there is in nature no vacuum; that all bodies are compoſed of four elements, heat and moiſture, cold and dryneſs; and that the body of man is from the earth, and his ſoul an equal mixture of theſe four elements. He argued with great ſubtlety againſt the poſſibility of motion. If Seneca's account of this philoſopher deſerves credit, he reached the higheſt point of ſcepticiſm, and denied the real exiſtence of external objects. The truth is, that after all that has been advanced by different writers, it is impoſſible to determine whether Zeno underſtood the term *one*, metaphyſically, logically, or phyſically; or whether he admitted or denied a nature properly divine.

Zeno, the founder of the ſect of the Stoics, was born about 300 years before Chriſt at Citium, in the iſland of Cyprus. This place having been originally peopled by a colony of Phœnicians, Zeno is ſometimes called a Phœnician. His father was by profeſſion a merchant, but diſcovering in the youth a ſtrong propenſity towards learning, he early devoted him to philoſophy. In his mercantile capacity he had frequent occaſion to viſit Athens, where he purchaſed for his ſon ſeveral of the writings of the moſt eminent Socratic philoſophers. Theſe he read with great avidity; and when he was about 30 years of age, he determined to take a voyage to a city which was ſo celebrated both as a mart of trade and of ſcience. If it be true, as ſome writers relate, that he brought with him a valuable cargo of Phœnician purple, which was loſt by ſhipwreck upon the coaſt of Piræus, this circumſtance will account for the facility with which he at firſt attached himſelf to a ſect whoſe leading principle was the contempt of riches. Upon his firſt arrival in Athens, going accidentally into the ſhop of a bookſellers, he took up a volume of the Commentaries of Xenophon; and after reading a few paſſages, was ſo much delighted with the work, and formed ſo high an idea of the author, that he aſked the bookſeller where he might meet with ſuch men. Crates the Cynic philoſopher happening at that inſtant to be paſſing by, the bookſeller pointed to him, and ſaid, "Follow that man." Zeno attended upon the inſtructions of Crates, and was ſo well pleaſed with his doctrine that he became one of his diſciples. But though he admired the general principles of the Cynic ſchool, he could not eaſily reconcile himſelf to their peculiar manners. Beſides, his inquiſitive turn of mind would not allow him to adopt that indifference to every ſcientific inquiry which was one of the characteriſtic diſtinctions of the ſect. He therefore attended upon other maſters, who profeſſed to inſtruct their diſciples in the nature and cauſes of things. When Crates, diſpleaſed at his following other philoſophers, attempted to drag him by force out of the ſchool of Stilpo, Zeno ſaid

ſaid to him, “ You may ſeize my body, but Stilpo has laid hold of my mind.” After continuing to attend upon the lectures of Stilpo ſeveral years, he paſſed over to other ſchools, particularly to thoſe of Xenocrates and Diodorus Cronus. By the latter he was inſtructed in dialectics. He was ſo much delighted with this branch of ſtudy, that he preſented to his maſter a large pecuniary gratuity, in return for his free communication of ſome of his ingenious ſubtleties. At laſt, after attending almoſt every other maſter, he offered himſelf as a diſciple of Polemo. This philoſopher appears to have been aware, that Zeno's intention in thus removing from one ſchool to another, was to collect materials from various quarters for a new ſyſtem of his own; for, when he came into Polemo's ſchool, he ſaid to him, “ I am no ſtranger, Zeno, to your Phœnician arts; I perceive that your deſign is to creep ſlyly into my garden, and ſteal away my fruit.” Polemo was not miſtaken in his opinion. Having made himſelf maſter of the tenets of others, Zeno determined to become the founder of a new ſect. The place which he made choice of for his ſchool was a public portico, adorned with the pictures of Polygnotus, and other eminent painters. It was the moſt famous portico in Athens, and called, by way of eminence, Στοα, “ the Porch.” It was from this circumſtance that the followers of Zeno were called *Stoics*.

In his perſon Zeno was tall and ſlender; his aſpect was ſevere, and his brow contracted. His conſtitution was feeble, but he preſerved his health by great abſtemiouſneſs. The ſupplies of his table conſiſted of figs, bread, and honey; notwithſtanding which, he was frequently honoured with the company of great men. In public company, to avoid every appearance of an aſſuming temper, he commonly took the loweſt place. Indeed ſo great was his modeſty, that he ſeldom choſe to mingle with a crowd, or wiſhed for the company of more than two or three friends at once. He paid more attention to neatneſs and decorum in external appearance than the Cynic philoſophers. In his dreſs indeed he was plain, and in all his expences frugal; but this is not to be imputed to avarice, but a contempt of external magnificence. He ſhowed as much reſpect to the poor as to the rich; and converſed freely with perſons of the meaneſt occupations. He had only one ſervant, or, according to Seneca, none.

Zeno lived to the extreme age of 98; and at laſt, in conſequence of an accident, voluntarily put an end to his life. As he was walking out of his ſchool he fell down, and in the fall broke one of his fingers; upon which he was ſo affected with a conſciouſneſs of infirmity, that, ſtriking the earth, he ſaid, “ Why am I thus importuned? I obey thy ſummons;” and immediately went home and ſtrangled himſelf. He died in the firſt year of the 129th Olympiad. The Athenians, at the requeſt of Antigonus, erected a monument to his memory in the Ceramicum.

We ought not to confound the two Zenos already mentioned with

Zeno, a celebrated Epicurean philoſopher, born at Sidon, who had Cicero and Pomponius Atticus for his diſciples, and who wrote a book againſt the mathematics, which, as well as that of Poſſidonius's refutation of it, is loſt; nor with ſeveral other Zenos mentioned in hiſtory.

ZENOBIA, queen of Palmyra. See Palmyra.

ZEOLITE, a mineral ſubſtance. See Mineralogy *Index*.

ZEPHANIAH, a canonical book of the Old Teſtament. See Scripture, n° 79.

ZEPHYR, the *West-Wind*, or that which blows from the cardinal point of the horizon oppoſite to the eaſt.

ZEPHYRUS, one of the Pagan deities, was repreſented as the ſon of Aurora, and the lover of the nymph Chloris, according to the Greeks, or of Flora according to the Romans; and as preſiding over the growth of fruits and flowers. He is deſcribed as giving a refreſhing coolneſs to the air by his ſoft and agreeable breath, and as moderating the heat of ſummer by fanning the air with his ſilken wings. He is depictured under the form of a youth, with a very tender air, with wings reſembling thoſe of the butterfly, and with his head crowned with a variety of flowers. As the poets of Greece and Rome lived in a warm climate, they are laviſh in in their praiſe of this beneficent deity, and under his name deſcribe the pleaſure and advantage they received from the weſtern breezes.

ZERDA. See Canis, Mammalia *Index*.

ZERTA, the Zerte, a fiſh caught in the rivers of Italy and ſome other places, of the figure of the chub, and called by authors *capito anodromus*, and the *blike*. It ſeldom grows to more than two pounds weight, and at times lives in rivers, at times in the ſea; and is eſteemed a very well taſted fiſh, eſpecially a little before the ſeaſon of its ſpawning. The zerte is that ſpecies of cyprinus deſcribed by Geſner and others under the name of *capito anodromus*.

ZEST, the woody thick ſkin quartering the kernel of a walnut; preſcribed by ſome phyſicians, when dried and taken with white wine, as a remedy againſt the gravel.

Zest is alſo uſed for a chip of orange or lemon peel; ſuch as is uſually ſqueezed into ale, wine, &c. to give it a flavour; or the fine oil which ſpurts out of that peel on ſqueezing it.

ZEUGMA, a figure in *Grammar*, whereby an adjective or verb which agrees with a nearer word, is alſo, by way of ſupplement, referred to another more remote.

ZEUS, a genus of fiſhes of the order of *thoracici*. See Ichthyology *Index*.

ZEUXIS, a celebrated painter of antiquity, flouriſhed about 400 years before Chriſt. He was born at Heraclea; but as there have been many cities of that name, it cannot be certainly determined which of them had the honour of his birth. Some learned men, however, conjecture, that it was the Heraclea near Crotona in Italy. He carried painting to a much higher degree of perfection than Apollodorus had left it; diſcovered the art of properly diſpoſing of lights and ſhades, and particularly excelled in colouring. He amaſſed immenſe riches; and then reſolved to ſell no more of his pictures, but gave them away; ſaying very frankly, “ That he could not ſet a price on them equal to their value.” Before this time he made people pay for ſeeing them; and nobody was admitted to ſee his Helena without ready money, which occaſioned the wags calling his picture *Helen the Courtezan*. It is not known whether this Helen of Zeuxis was the ſame with that which was at Rome in Pliny's time, or that which he painted for the inhabitants

inhabitants of Crotona to be hung up in the temple of Juno: this laſt he painted from five beautiful girls of that city, copying from each her greateſt excellencies. Pliny obſerves, that this admirable painter, diſputing for the prize of painting with Parrhaſius, painted ſome grapes ſo naturally, that the birds flew down to peck them. Parrhaſius, on the other hand, painted a curtain ſo very artfully, that Zeuxis, miſtaking it for a real one that hid his rival's work, ordered the curtain to be drawn aſide, to ſhow what Parrhaſius had done; but having found his miſtake, he ingeniouſly confeſſed himſelf vanquiſhed, ſince he had only impoſed upon birds, while Parrhaſius had deceived even a maſter of the art. Another time he painted a boy loaded with grapes; when the birds alſo flew to this picture, at which he was vexed; and confeſſed, that this work was not ſufficiently finiſhed, ſince had he painted the boy as perfectly as the grapes, the birds would have been afraid of him. Archelaus, king of Macedon, made uſe of Zeuxis's pencil for the embelliſhment of his palace. One of this painter's fineſt pieces was a Hercules ſtrangling ſome ſerpents in his cradle, in the preſence of his affrighted mother: but he himſelf chiefly eſteemed his Athleta, or Champion, under which he placed a Greek verſe that afterwards became very famous, and in which he ſays, "That it was eaſier to criticiſe than to imitate the picture." He made a preſent of his Alcmena to the Agrigentines. Zeuxis did not value himſelf on ſpeedily finiſhing his pictures; but knowing that Agatharchus gloried in his being able to paint with eaſe and in a little time, he ſaid, "That for his part he, on the contrary, gloried in his ſlowneſs; and, if he was long in painting, it was becauſe he painted for eternity." Verrius Flaccus ſays, that Zeuxis having painted an old woman, he laughed ſo very heartily at the ſight of this picture, that he died: but as no other of the ancients has mentioned this particular, there is the greateſt reaſon to believe it fabulous. Carlo Dati has compoſed in Italian the Life of Zeuxis, with thoſe of Parrhaſius, Apelles, and Protogenes. This work was printed at Florence in 1667.

ZICLAG, or ZIKLAG, in *Ancient Geography*, a town of the tribe of Simeon, on the borders of the Philiſtines (Joſhua xv. and xix.), but in the hands of the Philiſtines till David's time (1 Sam. xxvii. and xxx.)

ZIMENT-WATER, COPPER-WATER, the name by which ſome have called water found in places where there are copper-mines, which is impregnated with particles of that metal.

The moſt famous ſpring of this kind is about a mile diſtant from Newſohl in Hungary, in the great copper-mine called by the Germans *herrngrundt*. The water in this mine is found at different depths, and is received into baſons, for the purpoſe of ſeparating the copper from it: in ſome of theſe it is much more ſated with this metal than in others, and will make the ſuppoſed change of iron into that metal much ſooner. The moſt common pieces of iron uſed in the experiments are horſeſhoes, nails, and the like; and they are found very little altered in ſhape, after the operation, except that their ſurfaces are more raiſed. The water appears greeniſh in the baſon, where it ſtands; but if a glaſs of it be taken up, it looks clear as cryſtal: it has no ſmell, but a ſtrong vitriolic aſtringent taſte, inſomuch that the lips and tongue are bliſtered and ſcorched upon taſting it.

ZIN, in *Ancient Geography*, a wilderneſs encompaſſing Idumea, at leaſt on the ſouth and weſt, as far as Paleſtine or Canaan; but according to Wells, on the eaſt of Edom, to the north of Ezion-gaber.

ZINC, a metallic ſubſtance, formerly conſidered as one of the brittle metals; or, according to the diſtinction of the older chemiſts, a *ſemi-metal* or an imperfect metal, becauſe it was found to be deſtitute of ſome of the properties of other metals which were conſidered as perfect. For an account of the properties and combinations of zinc, as they were then known, ſee CHEMISTRY *Index*; and for the hiſtory of its ores, ſee MINERALOGY *Index*.

But in the progreſs of chemical diſcovery it has been found that zinc is not a leſs perfect metal than others; for in the year 1805, it was announced that a patent was granted to Meſſrs Hobſon and Sylveſter of Sheffield for a method of manufacturing zinc. From their diſcovery it appears, that zinc raiſed to a temperature of between 210° and 300° of Fahrenheit, is not only very malleable, but may be paſſed through rollers, or drawn into wire. After the metal has been treated in this manner, it does not return to its former brittleneſs, but continues ſoft, flexible, and extenſible, and may be applied to many uſes for which this metal was before thought unfit *.

We muſt, however, notice, that a prior claim to the diſcovery of rendering zinc ductile and malleable, has been made by Mr Lowry, in favour of a Mr Sheffield of Somerſtown. Twenty years before the time of Meſſrs Hobſon and Sylveſter's patent being announced, Mr Sheffield, in making an aſſay of ſome blende, was impatient to examine the metal, ſtruck an ingot for the purpoſe of breaking it while it was yet hot, but was much ſurpriſed to find that inſtead of being brittle, and breaking with the uſual fracture of zinc, it was extremely tough, and when he ſucceeded in breaking it, after many bendings backward and forward, it exhibited a ſteel-grained fibrous texture. At firſt he doubted of the metal being zinc, but he repeated the experiment on what he knew to be pure metal, and obtained the ſame reſult; and from this he concluded that zinc at a certain temperature is equally malleable and ductile with other metals. This he found to be the caſe by drawing it into wire, and laminating it between rollers, by which he produced plates not exceeding the $\frac{1}{200}$ of an inch, and poſſeſſing the ſtrength and tenacity of ſilver †.

Since the time that our article CHEMISTRY was printed, the decompoſition of potaſh, ſoda, the alkaline earths, and ſome other bodies which were formerly conſidered as ſimple, or were only conjectured from analogy to be compound, has been effected by Mr Davy; and as we were diſpoſed to entertain hopes that ſomething new might be added to the unexpected and brilliant diſcoveries of that celebrated chemiſt, we have deferred, till near the cloſe of our work, giving any account of them. This is the reaſon that the fact was merely announced under the words POTASH and SODA, and a reference made to *Galvanic* TROUGH, under which it was intended to give a ſhort deſcription of the apparatus employed in the experiments which led to the diſcoveries alluded to. For the ſame reaſon we were induced to make a farther reference to this place, becauſe zinc is

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* *Phil. Mag.* xxiii. 92.

† *Phil. Mag.* xxiii. 282.

one of the metallic ſubſtances uſually employed in the conſtruction of galvanic apparatus. We ſhall therefore here employ a few pages, 1ſt, In a deſcription of the improvements which have been made in the conſtruction of galvanic apparatus; and, 2d, We ſhall lay before our readers a view of the diſcoveries in galvanic electricity ſince the treatiſes on CHEMISTRY and GALVANISM in this work were printed.

Galvanic Apparatus.—A very conſiderable improvement has been made on the conſtruction of galvanic batteries, by which they are rendered, not only more convenient and manageable, but far more powerful. Under the article GALVANISM, we have deſcribed particularly the conſtruction of the galvanic trough, and we have noticed that the ſoldering of the plates of zinc and copper employed for this purpoſe was attended with conſiderable difficulty. In the new method of conſtruction the plates are not ſoldered together, but are merely connected by means of a metallic arc. In this way each pair of plates can be removed from the trough at pleaſure, for the purpoſe of examining and cleaning them. The new apparatus is conſtructed preciſely on the ſame principle as the *couronne de Taſſes*, propoſed by Volta, and deſcribed at p. 333 of GALVANISM. The trough employed in this apparatus is prepared in the ſame way as when the plates of zinc and copper ſoldered together were fixed in it by means of cement; but in place of the metallic plates, plates of glaſs, or ſome other non-conducting ſubſtance, are introduced and ſecured by cement, ſo that there ſhall be no communication between the different cells into which the liquid is introduced. The plates of zinc and copper connected by means of the metallic arc, at the diſtance of about half an inch, are placed in different cells, having a plate of glaſs between each pair of plates. Each cell then contains a plate of each of the metals, which are unconnected, excepting through the medium of the liquid which is to be the conductor of the electricity. It is ſcarcely neceſſary to mention, that the proper order of arrangement ſhall be obſerved, ſo that throughout the whole trough or battery there ſhall be a ſeries of zinc, copper, and liquid.

Beſide the conveniency and ſimplicity of this mode of conſtructing galvanic troughs, it poſſeſſes this farther advantage of being more powerful, becauſe inſtead of one ſurface of the plates, as in the former conſtruction of this apparatus, both ſurfaces are expoſed to the action of electricity, and therefore the power is greatly increaſed. A farther improvement, it is ſaid, has been made in conſtructing batteries of this kind, which conſiſts in employing troughs of Wedgwood's ware, with partitions of the ſame material, inſtead of wooden troughs with partitions of glaſs. This improvement was firſt ſuggeſted by Dr Babington.

The following is the account of the conſtruction of galvanic apparatus, with the view of aſcertaining in what way the greateſt effect might be produced, with the leaſt waſte of power and expence. The experiments which we are now to mention were made by Mr Children *. For this purpoſe a battery was conſtructed on the new method, with plates of copper and zinc, connected by leaden ſtraps, ſoldered on the top of each pair of plates. Twenty pairs of plates were employed, and each plate was four feet high by two feet wide. The whole extent of ſurface expoſed amounted to 92,160 ſquare inches; the trough was made of wood, with wooden partitions, covered with cement, to reſiſt the action of the acid employed. The battery was charged with a mixture of three parts of fuming nitrous, and one of ſulphuric acid, diluted with thirty of water; the quantity employed was 120 gallons. With this apparatus the following experiments were made.

Exper. 1. Eighteen inches of platina wire, of one-thirtieth of an inch diameter were completely fuſed in about twenty ſeconds. *Exper.* 2. Three feet of the ſame wire were heated to a bright red, viſible by ſtrong day-light. *Exper.* 3. Four feet of the ſame wire were rendered very hot, but not perceptibly red by day-light. *Exper.* 4. Charcoal burnt with intenſe brilliancy. *Exper.* 5. Ten inches of iron-wire of $\frac{1}{10}$th of an inch diameter, were barely fuſed; three feet of the ſame wire were not ignited. *Exper.* 6. No effect was produced on imperfect conductors. *Exper.* 7. The gold-leaves of the electrometer were not affected. *Exper.* 8. When the cuticle was dry, no ſhock was given by the battery, and it was ſcarcely perceptible when the ſkin was wet.

To contraſt the effects of this apparatus with another differing in the ſize and number of plates, the author employed 200 pairs of plates, each about two inches ſquare, placed in half pint pots of common queen's ware. The ſame liquid was employed, with the addition of a freſh portion of ſulphuric acid, in the proportion of about a quarter of a pint to a gallon. The experiments with this apparatus gave the following reſults.

Exper. 1. Potaſh and barytes were readily decompoſed. *Exper.* 2. The metallization of ammonia was produced with great facility. *Exper.* 3. Charcoal was vividly ignited. *Exper.* 4. The gold leaves of the electrometer diverged conſiderably. *Exper.* 5. After the battery was in action three hours, it gave a vivid ſpark; at the end of 24 hours it metallized ammonia; at the end of 41 hours it was nearly exhauſted. From the reſults of theſe experiments, Mr Children concludes, that the theory of the mode of action of the voltaic battery propoſed by Mr Davy is confirmed, namely, that the intenſity increaſes with the number, and the quantity with the extent of the ſeries. This is proved by the effects produced on the platina and iron wires, in the 1ſt and 5th experiments with the large battery, as well as by the experiments on imperfect conductors in the ſmall apparatus; for as the platina wire is a perfect conductor, and not liable to oxidation, it allows the electricities to be freely tranſmitted, and from the immenſe quantity given out from a ſurface of ſuch extent, they evolve, on their mutual annihilation, heat ſufficient to raiſe the temperature of the platina to the point of fuſion. But a very ſmall portion of the electricity paſſes through the iron wire, in conſequence of its eaſy oxidation, and the thin coat of oxide formed on its ſurface. This ariſes from the low ſtate of the intenſity of the electricity, as appears alſo from its want of power on the gold leaves of the electrometer. From the ſame deficient intenſity, the decompoſition of barytes could not be effected by the large battery, and the ſame battery exhibited a very weak action on imperfect conductors; but the ſmall battery exerted great power on that claſs of bodies, and decompoſed them readily, although its ſurface was 30 times leſs than the ſurface of the great battery; but the number

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* *Phil. Tranſ.* 1809, p. 32.

ber of plates was nearly ten times greater. Another circumſtance, of conſiderable importance in conducting experiments by means of the galvanic battery, is here noticed by the author; that the long continued action of the ſmall battery was owing to the large capacity of the cells containing a proportional quantity of liquor. And beſide this advantage he adds, that with very large combinations, a certain diſtance between each pair of plates is abſolutely neceſſary to prevent ſpontaneous diſcharges, which are accompanied with vivid flaſhes of electric light. This happened to the author with a battery of 1250 four-inch plates, conſtructed according to the new method.

From the experiments and obſervations, ſome of which we have detailed, and for others we refer to the paper itſelf, the author concludes with the following remarks: "The abſolute effect of a voltaic apparatus ſeems to be in the compound ratio of the number and ſize of the plates. The intenſity of the electricity being as the former, the quantity given out as the latter, conſequently regard muſt be had, in its conſtruction, to the purpoſes for which it is deſigned. For experiments on imperfect conductors, very large plates are to be preferred, a ſmall number of which will probably be ſufficient; but where the reſiſtance of imperfect conductors is to be overcome, the combination muſt be great, but the ſize of the plates may be ſmall: but if quantity and intenſity be both required, then a large number of large plates will be neceſſary. For general purpoſes, four inches ſquare will be found to be the moſt convenient ſize *."

Diſcoveries in Galvaniſm.—At the cloſe of the article GALVANISM, we noticed ſome experiments which were made about the beginning of the year 1805, which ſeemed to lead to the concluſion, that muriatic acid and ſoda were formed by means of galvanic electricity. In experiments on the decompoſition of water, which was ſuppoſed to be in a ſtate of the utmoſt purity, the appearance of muriatic acid and ſoda was adduced in ſupport of this opinion. The accuracy of this concluſion, which ſeemed to be at variance with known facts, excited doubt, and probably led to the inveſtigation which was undertaken by Mr Davy, and carried on with great ingenuity and addreſs by the ſame philoſopher, till it terminated in the brilliant diſcoveries, an account of which we are now to detail. Mr Davy's reſearches in galvaniſm, an account of which he laid before the Royal Society in a memoir entitled, *On ſome Chemical Agencies of Electricity*, may be conſidered as the firſt ſtep in this train of inveſtigation.

Plate DLXXVIII. Fig. 1.

With the view of diſproving the accuracy of the experiments in which the generation of acids and alkalies was ſuppoſed to have been effected by means of galvaniſm, Mr Davy employed agate cups, (fig. 1.), of a cylindrical form, and containing about one-fourth of a cubic inch each. The cups were boiled for ſome hours in diſtilled water, and a piece of white tranſparent amianthus, which had been treated in the ſame way, was made to connect them. They were then filled with diſtilled water, and expoſed by means of two platina wires, to a current of electricity, from 150 pairs of plates of copper and zinc, four inches ſquare. The liquid employed was a ſolution of alum. The action continued 48 hours, and the proceſs was then examined. Paper tinged with litmus introduced into the tube containing the poſitive wire, was reddened; paper coloured by turmeric placed in the other tube, had its colour deepened; the acid matter produced a ſlight turbidity in a ſolution of nitrate of ſilver; the fluid from the negative tube retained the property of affecting the turmeric after being boiled, and indeed became more vivid as the quantity was diminiſhed by evaporation. Carbonate of ammonia was added, and the whole being dried, and expoſed to a ſtrong heat, a minute quantity of white matter remained, which had all the properties of carbonate of ſoda.

The ſame experiment was repeated with glaſs tubes, and the reſult was, that the quantity of alkali obtained was 20 times greater, but no traces of muriatic acid could be perceived. Mr Davy ſuſpecting that the agate might contain a minute portion of ſaline matter, repeated the experiment four times. The quantity of alkaline matter diminiſhed in every operation, and in the laſt proceſs, although the battery had been kept in great activity for three days, the fluid poſſeſſed in a ſlight degree only the power of acting on paper tinged with turmeric; but its alkaline property was very ſenſible to litmus paper ſlightly reddened. The acid matter in the other tube was abundant; it had a ſour taſte, and produced no effect on ſolution of muriate of barytes, but left a black ſtain from a drop on a poliſhed plate of ſilver. Thus it appeared to be extremely diluted nitrous acid.

Fig. 2.

For the purpoſe of making the experiment with greater accuracy, two hollow cones of pure gold (fig. 2.) were employed, each containing about 25 grains of water. They were filled with diſtilled water, connected by moiſtened amianthus, as before, and expoſed to the action of a battery of 100 pairs of plates of ſix inches ſquare. The liquid uſed was a ſolution of alum, and diluted ſulphuric acid. In ten minutes the water in the negative tube changed litmus paper to a ſlight blue, and the water in the poſitive tube produced a red tint. The proceſs having continued for 14 hours, the acid was found to increaſe in quantity during the whole time, but the alkaline fluid in the other tube did not affect the teſts more than in the firſt trial. The acid ſeemed to be the pure nitrous, with an exceſs of nitrous gas. The experiment was repeated, and the proceſs carried on for three days, and ſimilar reſults were obtained. From theſe experiments it was concluded, that the diſtilled water contained a minute portion of ſaline matter, but ſo minute indeed, that it was inſenſible to the moſt delicate chemical teſts. This appeared to be the caſe by evaporating a quantity of the diſtilled water that was uſed, very ſlowly, at a heat below 140° Fahrenheit, in a ſilver ſtill. A quantity of ſolid matter equal to ſeven-tenths of a grain, of a ſaline but metallic taſte, was obtained. It ſeemed to be a mixture of nitrate of ſoda and nitrate of lead. Mr Davy then employed ſome of the water collected in the ſecond proceſs of ſlow diſtillation, in another experiment with the gold tubes and connecting amianthus. At the end of two hours the water in the negative tube had no effect on turmeric paper; litmus, it could juſt be perceived, was changed; but by heating the water ſtrongly for two or three minutes, it was deprived even of this power, and from this he ſuppoſes that it was owing to a ſmall quantity of ammonia. A ſimilar experiment was made with a portion of the ſame water in the agate tubes, and preciſely the ſame reſults were obtained. From theſe

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* Ibid. 37.

experiments Mr Davy fairly concludes, that the fixed alkali is not generated during the proceſs, but merely evolved, either from the ſolid materials employed, or from ſaline matter in the water.

Many experiments were made in veſſels compoſed of different ſubſtances, with the water procured by ſlow diſtillation; and in almoſt every inſtance ſome fixed alkali appeared. When tubes of wax were employed, the alkaline matter was a mixture of ſoda and potaſh, and the acid matter, a mixture of ſulphuric, muriatic, and nitric acids. A tube of reſin afforded alkaline matter, which was principally potaſh. A cube of Carrara marble of about an inch, having an aperture in its centre, was placed in a platina crucible, which was filled as high as the upper ſurface of the cube, with the purified water. The aperture was filled with the ſame liquid, and the crucible was poſitively electrified by a powerful battery, and the negatively electrified wire introduced into the aperture. Fixed alkali and lime were obtained in this experiment; the quantity of alkali diminiſhing as the experiment was repeated, and after 11 proceſſes, each continued for two or three hours, diſappeared altogether. The quantity of lime-water obtained was uniform.

When 500 grains of this marble were analyzed, they afforded about three-fourths of a grain of fixed ſaline matter, having ſoda for its baſe. Suſpecting that the Carrara marble might have been recently expoſed to ſea water, Mr Davy ſubjected to a ſimilar experiment, a piece of granular marble from the mountains of Donnegal, and by means of negative electricity he obtained fixed alkali. Argillaceous ſchiſtus from Cornwall gave the ſame reſult, and ſerpentine and gray wacken both afforded ſoda.

In other experiments Mr Davy ſubjected other bodies to the action of the ſame power, with the view of effecting a decompoſition. Thus, two cups of compact ſulphate of lime, each containing about 14 grain meaſures of water, were connected by fibrous ſulphate of lime moiſtened with pure water. The cups were filled with the ſame fluid, and they were introduced into the circuit of a galvanic battery with 100 pairs of plates of ſix inches. In five minutes the water in the poſitive cup became acid, while that in the oppoſite cup tinged turmeric. An hour after, a ſaturated ſolution of lime was formed in the negative cup, and the other contained a ſolution of ſulphuric acid of moderate ſtrength.

Two cubical pieces of cryſtallized ſulphate of ſtrontites, of about an inch, with a hole drilled in each, capable of receiving eight grains of water, were plunged in pure water, in a platina crucible, and the level of the fluid was kept a few lines below the ſurface of the cubes. The holes in the earthy mineral were filled with pure water, and two platina wires were introduced into them. At the end of thirty hours the fluid in the cavity of the negative ſide precipitated ſolution of ſulphate of potaſh, and ſulphuric acid appeared in the other.

Two pieces of fluate of lime, having each a cavity, and connected by moiſt aſbeſtus, were ſubjected to a ſimilar experiment. The decompoſition was ſlow; but in two days a ſolution of lime appeared in the one tube, and an acid in the other, which precipitated acetate of lead, and left a ſpot upon the glaſs, from which it was evaporated, ſo that it muſt have been fluoric acid.

Compact zeolite being prepared in the ſame way, and electrified in the ſame manner as the cube of Carrara marble, afforded ſoda and lime. Lepidolite, by ſimilar treatment, gave potaſh; and an alkaline matter, which ſeemed to be a mixture of ſoda, potaſh and lime, was extracted from a piece of vitreous lava from Mount Etna.

The decompoſition of ſaline bodies, which are ſoluble in water, was more rapid. A diluted ſolution of ſulphate of potaſh introduced into the agate cups connected by amianthus moiſtened with pure water, being electrified by a battery with 50 pairs of plates, produced in four hours a weak ſolution of potaſh in the negative cup, and a ſolution of ſulphuric acid in the poſitive cup. Similar phenomena were obſerved when ſulphate of ſoda, nitrate of potaſh, nitrate of barytes, ſulphate of ammonia, phoſphate of ſoda, ſuccinate, oxalate, and benzoate of ammonia and alum, were employed. The acids in a certain time collected in the tube containing the poſitive wire, and the alkalies and earths in the negative tube. Solutions of the muriatic ſalts, ſubjected to decompoſition by the ſame proceſſes, uniformly afforded oxymuriatic acid on the poſitive ſide.

Saturated ſaline ſolutions were moſt rapidly decompoſed, but the ſmalleſt proportion was alſo acted on. Thus, if a piece of paper tinged with turmeric be plunged into pure water, in a proper circuit, in contact with the negative point, the minute quantity of ſaline compound contained in the paper, produces inſtantly a brown tint near its point of contact. Acid appears alſo from litmus paper at the poſitive ſurface.

Experiments were made with the view of aſcertaining whether in theſe proceſſes the ſeparation of the conſtituent parts was complete, from the laſt portions of the compound. The following experiment ſhows that this is the caſe. "A very weak ſolution of ſulphate of potaſh, containing 20 parts of water, and one part of ſaturated ſolution at 64°, was electrified in the two agate cups, by the power of 50 pairs of plates for three days; the connecting amianthus which had been moiſtened with pure water, was removed, waſhed with pure water, and again applied twice every day. By this precaution the preſence of any neutral ſalt that might adhere to it, and diſturb the reſults, was prevented. The alkali obtained in this proceſs in the ſolution had the properties of pure potaſh, and when it had been ſaturated with nitric acid, it gave no turbidneſs by mixture with ſolution of muriate of barytes; the acid matter expoſed to a ſtrong heat, evaporated, without leaving any reſiduum."

Mr Davy then made experiments on the transfer of certain of the conſtituent parts of bodies, and alſo on the paſſage of acids, alkalies, and other ſubſtances, through various attracting chemical menſtrua, by means of electricity, and in theſe experiments he obtained many curious and intereſting reſults; but for an account of them, as well as of his obſervations on the different phenomena, and on the mode of decompoſition and tranſition, we muſt refer to the memoir itſelf.

After the inveſtigations in which Mr Davy had been occupied, and the ſingular and unexpected reſults which he obtained, he ventured to conclude, from the general principles on which the phenomena might be explained, that the new methods of proceeding would lead to a more intimate knowledge concerning the true elements of of bodies. Accordingly, in November 1807, he laid before the Royal Society a moſt intereſting detail of an elaborate ſeries of experiments on the decompoſition of the alkalies.

Decompoſition of the Alkalies.

In the firſt attempts that were made on the decompoſition of potaſh, Mr Davy employed an aqueous ſolution, ſaturated at a common temperature. It was expoſed to the action of a powerful galvanic battery, compoſed of 24 plates of copper and zinc of 12 inches ſquare, 100 plates of ſix inches, and 150 plates of four inches ſquare, charged with ſolutions of alum and nitrous acid. The action was very intenſe; a great deal of heat and violent effervеſcence were produced, but the water only of the ſolution was affected, and its hydrogen and oxygen were diſengaged. Potaſh in the ſtate of igneous fuſion, in a ſpoon of platina, was next ſubjected to the action of a battery of 100 plates of ſix inches, highly charged. The ſpoon was connected with the poſitive ſide. In this experiment ſome brilliant phenomena were produced. The potaſh appeared to be a good conductor; and, while the communication was preſerved, a moſt intenſe light was emitted from the negative wire, and a column of flame, ſeemingly owing to the developement of combuſtible matter, aroſe from the point of contact. When the order was reverſed, and the platina ſpoon was connected with the negative ſide, a vivid and conſtant light appeared at the oppoſite point. There was no inflammation round it; but aeriform globules, which inflamed in the atmoſphere, roſe through the potaſh. The platina was conſiderably acted on.

Although potaſh, when perfectly dry, be a non-conductor, it acquires a conducting power by being ſlightly moiſtened. A ſmall piece of pure potaſh expoſed for a few ſeconds to the atmoſphere, was placed on a diſc of platina connected with the negative ſide of a battery of 250 plates of ſix and four inches, in a ſtate of intenſe activity. A platina wire from the oppoſite ſide was brought in contact with the upper ſurface of the alkali. A vivid action ſoon took place. The potaſh fuſed at both points of electriſation; a violent effervеſcence appeared at the upper ſurface; but at the lower or negative ſurface no elaſtic fluid was emitted, but ſmall globules like quickſilver were produced, ſome of which burnt with exploſion and bright flame as they were formed, and others remained and were only tarniſhed, and finally covered by a white film formed on their ſurfaces. Theſe globules were the baſis of potaſh. The ſame reſults were obtained, when gold and other metals, plumbago, or charcoal, were employed; and the effects were the ſame when the proceſs was conducted in an exhauſted receiver.

Mr Davy alſo obtained the ſame ſubſtance from potaſh, fuſed by means of a lamp, and placed in glaſs tubes confined by mercury, and furniſhed with hermetically inſerted platina wires, to tranſmit the electricity; but the glaſs was rapidly diſſolved by the action of the alkali, ſo that the proceſs could not be long carried on.

In theſe experiments on potaſh, the combuſtible baſe was produced from the negative ſurface, and oxygen was evolved from the poſitive ſurface. The ſame effects invariably followed, when the experiment was conducted above mercury. The ſame thing was proved ſynthetically. The combuſtible ſubſtance obtained from the potaſh had its metallic luſtre deſtroyed in the atmoſphere, and a white cruſt formed upon it. This cruſt was found, upon examination, to be pure potaſh; but this was ſtill farther confirmed by placing globules of the combuſtible matter in tubes containing common air, or oxygen gas, confined by mercury. An abſorption of the oxygen took place, and a cruſt of alkali was formed upon the globule. When the combuſtible matter confined in given portions of oxygen, was ſtrongly heated, a rapid combuſtion, with a brilliant white flame, was produced, and the metallic globules were converted into a white and ſolid maſs, which was found to be pure potaſh.

To the combuſtible matter thus obtained from potaſh, Mr Davy gave the name of *potaſſium*. From its ſtrong affinity for oxygen, it was extremely difficult to preſerve it unchanged, for the purpoſe of examining its properties. The ſubſtance which he found to be leaſt affected, is newly diſtilled naphtha. In this fluid potaſſium may be kept for many days nearly unaltered, and its phyſical properties may be examined in the atmoſphere, when covered by a thin film of it.

Potaſſium, at 60° Fahrenheit, is in the form of ſmall globules, which have the metallic luſtre and general appearance of mercury; at 70° it becomes more fluid, and at 100°, different globules eaſily run into one. At 50° of Fahrenheit it is ſoft and malleable, and exhibits the luſtre of poliſhed ſilver. At 32° it becomes hard and brittle, and, when broken, preſents a cryſtallized texture. To reduce it to vapour, it requires a red heat; and in proper circumſtances, it may be ſubjected to diſtillation, without change. It is a good conductor of heat, and a perfect conductor of electricity.

In the properties now mentioned, potaſſium approaches nearly to the metals; but it is very different in its ſpecific gravity. In naphtha of the ſpecific gravity of .861 it roſe to the ſurface; and it did not ſink in double diſtilled naphtha, the ſpecific gravity of which was about .770. From theſe and other experiments, Mr Davy eſtimates the ſpecific gravity of potaſſium at .6, ſo that it is the lighteſt fluid body known. In its ſolid form it is ſomewhat heavier; but, even in this ſtate, when cooled to 40° Fahrenheit, it ſwims in double diſtilled naphtha.

With the view of aſcertaining the proportions of the conſtituent parts of potaſh, Mr Davy made two experiments, by ſubjecting the metallic baſe to combuſtion in oxygen gas. In the firſt experiment, .12 of a grain of potaſſium were employed; the combuſtion was made upon platina, and was rapid and complete, and the baſis appeared to be perfectly ſaturated. The reſult of this experiment indicates 86.7 of baſis, and 13.3 of oxygen, in the 100 parts of potaſh. In another experiment, the reſult he obtained was 85.5 of baſis, and 14.5 of oxygen. The mean of theſe two experiments is 86.1 of baſis, and 13.9 of oxygen, in 100 parts of potaſh.

The reſults of the decompoſition of water by the baſis of the alkalies, which were more readily and perfectly obtained than thoſe of their combuſtion, exhibited the proportion of baſe to be 84, and that of oxygen 16; but the mean of 86.1 of baſe, and 13.9 of oxygen, and 84 baſe and 16 oxygen, is 85 of potaſſium and 15 of oxygen, which may be taken as the proportions of the elements of potaſh.

Mr Davy's diſcoveries have been confirmed by the

ingenious

ingenious experiments of Thenard and Gay-Luſſac. Theſe diſtinguiſhed chemiſts have decompoſed potaſh by a different proceſs. They introduced iron filings into a bent gun barrel, which was placed acroſs a furnace. A tube with a ſtopcock, containing a quantity of ſolid potaſh, is connected with one extremity of the gun barrel; to the other extremity there is attached a tube of ſafety, containing mercury, for the purpoſe of excluding the atmoſpheric air, and allowing any gaſeous matter formed during the proceſs to eſcape. The potaſh in the tube is to be kept cold by means of a freezing mixture, till that part of the barrel containing the iron filings has been raiſed to a white heat. The potaſh is then fuſed by applying heat, by means of a portable furnace; and it is allowed to paſs through a ſmall opening, to come in contact with the iron filings, where it is decompoſed, the oxygen of the potaſh entering into combination with the iron, and the baſe paſſing on to the other extremity of the tube in a ſtate of ſublimation. At that extremity the metallic baſe is condenſed by the application of exceſſive cold, and in this way the potaſſium may be obtained at leſs expence, and in greater quantity, than by means of galvaniſm. During this proceſs, hydrogen gas is evolved, which, it is ſuppoſed, is owing to the decompoſition of the water contained in the alkali. The potaſſium thus obtained is in the form of brilliant laminæ, which adhere to the ſides of the gun barrel. An alloy of the ſame metal with iron is alſo found in that part of the barrel containing the filings. Mr Davy has repeated this experiment, and he finds that the baſe obtained in this manner is heavier, and its melting point higher, than what is procured by means of galvaniſm. This, it is ſuppoſed, may ariſe from its being combined with a ſmall proportion of iron. The metallic baſe of ſoda was obtained by a ſimilar proceſs.

But, according to the view which the French chemiſts have taken of theſe diſcoveries, and the reſults of their own experiments, they conclude, that the metallic ſubſtances derived from the alkalies are not ſimple, but are compounds of the ſeveral baſes with hydrogen.

Another method of decompoſing potaſh, and obtaining its baſe, which is ſtill ſimpler, has been followed by Curaudau. In this proceſs the decompoſition is effected by charcoal. A mixture of carbonate of potaſh is made with flour or charcoal and linſeed oil. This mixture is introduced into an iron or earthen tube or retort, and calcined, by gradually raiſing the heat, till a bluiſh light be ſeen in the inſide of the veſſel. Soon after an abundant evolution of vapour takes place, which is the baſe of the alkali, to be collected by introducing a clean iron rod, on which it condenſes. Care muſt be taken to withdraw the rod before it is too hot, and to plunge it in oil of turpentine, under the ſurface of which the metallic cruſt on the rod may be ſeparated. In this way a quantity of potaſſium may be procured. The baſe of ſoda is obtained by a ſimilar proceſs.

Fig. 3. Fig. 3. is a repreſentation of the apparatus employed by the French chemiſts in decompoſing potaſh. ABCE is the gun barrel laid acroſs the furnace, with its apparatus; D is the furnace, and F is the pipe of the bellows.

Fig. 4. Fig. 4. is a ſection of the tube containing the potaſh.

But the chemical relations of potaſſium are not leſs extraordinary than its phyſical properties. It combines ſlowly with oxygen, and without flame, at all temperatures below that of its vaporization. At this point combuſtion takes place, with a brilliant white light, and intenſe heat. When it is heated ſlowly in a quantity of oxygen gas, which is not ſufficient for its complete ſaturation, and at a temperature below that of inflammation, as for inſtance 400° of Fahrenheit, it changes to a red brown colour, and the ſolid form, conſiſting partly of potaſh, and partly of its baſe, is of a grayiſh colour. When expoſed to water, or again heated in freſh quantities of air, the whole is converted into potaſh. When dry potaſh and potaſſium are fuſed together under proper circumſtances, the baſe is deprived of its metallic ſplendour, and the two ſubſtances unite into a compound of a red brown colour when fluid, and of a dark gray when ſolid. This compound, when expoſed to the air, ſoon abſorbs its full proportion of oxygen, and is wholly converted into potaſh. The ſubſtance thus formed ſeems to be in a lower ſtate of oxidation, ſo that it is to be conſidered as an oxide of potaſſium with a ſmaller proportion of oxygen.

When potaſſium is introduced into oxymuriatic acid gas, it burns ſpontaneouſly with a bright red light, and a white ſalt is formed, which is muriate of potaſh. When a globule of potaſſium is heated in hydrogen gas, at a degree below its point of vaporization, it ſeems to diſſolve in it, for the globule is diminiſhed in volume, and the gas explodes with alkaline fumes, and bright light, when brought into the air; but, by cooling, the potaſſium is wholly or principally depoſited, for the gas is deprived of its property of ſpontaneous detonation.

When potaſſium is thrown into water, it decompoſes it with great violence; an inſtantaneous exploſion, with brilliant flame, is produced, and a ſolution of pure potaſh is obtained. In theſe experiments, a white ring of ſmoke, gradually extending as it riſes in the air, is produced, ſimilar to the phenomenon of the combuſtion of phoſphorated hydrogen. When a globule of the baſis of potaſh is placed upon ice, it inſtantly burns with a bright flame; part of the ice is melted, and in the cavity there is found a ſolution of potaſh.

By placing a globule of potaſſium upon moiſtened paper, tinged with turmeric, the moment that it comes in contact with the water, it burns, and, moving rapidly upon the paper, leaves behind it a deep reddiſh brown trace, thus demonſtrating, in a very ſimple manner, the production of the alkali by the decompoſition of water.

Potaſſium readily decompoſes the ſmall quantities of water contained in alcohol and ether, even in their pureſt ſtate. As potaſh is inſoluble in ether, when the baſe is thrown into it, oxygen is furniſhed to it, and hydrogen gas evolved, and, as the alkali is formed, the ether becomes white and turbid. It is obſerved, that the energy of action of potaſſium in ether and alcohol, is proportional to the quantity of water which they contain, and hydrogen and potaſh are always produced.

When potaſſium is thrown into ſolutions of the mineral acids, it inflames and burns on the ſurface, and when plunged, by proper means, beneath the ſurface enveloped in potaſh, ſurrounded by naphtha, it acts upon the oxygen with great intenſity. In ſulphuric acid, a white ſaline ſubſtance, covered with a yellow coating, which is ſuppoſed to be ſulphate of potaſh ſurrounded with ſulphur, and a gas, having the ſmell of ſulphurous acid, and

and which is probably a mixture of that ſubſtance with hydrogen gas, are formed. When potaſſium is thrown into nitrous acid, nitrate of potaſh is formed, and nitrous gas is diſengaged.

Potaſſium readily combines with phoſphorus and ſulphur. When preſſed upon a piece of phoſphorus, they both become fluid, enter into combuſtion, and produce phoſphate of potaſh. When the experiment is made upon naphtha, no gaſeous ſubſtance is given out; the compound has the appearance of a metallic phoſphuret, is of the colour of lead, and has the luſtre of poliſhed lead. Expoſed to the air at common temperatures, it combines ſlowly with oxygen, and is converted into phoſphate of potaſh. When heated upon a plate of platina, it gives out fumes, but does not burn till it reaches the temperature of the rapid combuſtion of potaſſium.

When potaſſium is brought into contact with ſulphur in fuſion, in tubes filled with the vapour of naphtha, they combine rapidly, with the evolution of heat and light. A gray ſubſtance is thus formed, which has the appearance of artificial ſulphuret of iron; if it be kept in fuſion, it rapidly diſſolves the glaſs. When this experiment is made in a glaſs tube, hermetically ſealed, no gas is diſengaged, if the tube be opened under mercury; but when it is made in a tube connected with a mercurial apparatus, a ſmall quantity of ſulphurated hydrogen is evolved. When the combination is effected in the atmoſphere, a great inflammation takes place, and ſulphuret of potaſh is formed, and by farther expoſure to the air, it is at laſt converted into ſulphate of potaſh.

When one part of potaſſium is added to eight or ten of mercury, in bulk, at 60° of Fahrenheit, they inſtantly unite, and form a ſubſtance like mercury in colour, but leſs coherent. When a globule is made to touch a globule of mercury about twice as large, they combine with conſiderable heat. The compound is fluid at the temperature of its formation, but, when cool, it becomes ſolid, with the appearance of ſilver. With the $\frac{1}{10}$th of potaſſium to the weight of mercury, the amalgam is hard and brittle; but with one part of potaſſium, and 70 of mercury, it is ſoft and malleable. Expoſed to the air, theſe compounds abſorb oxygen, and deliqueſcent potaſh is formed; and in a few minutes the mercury is revived. A globule of the amalgam, thrown into water, decompoſes it rapidly with a hiſſing noiſe; potaſh is formed; pure hydrogen is diſengaged, and the mercury remains free. This amalgam diſſolves all the metals, and even acts on iron and platina.

When potaſſium is heated with gold, ſilver, or copper, in a cloſe veſſel of pure glaſs, a rapid action is produced, and the compounds thrown into water effect its decompoſition; potaſh is formed, and the metals are revived. Potaſſium forms an alloy with fuſible metal, which has a higher point of fuſion than the fuſible metal itſelf.

Potaſſium has little effect on colourleſs and recently diſtilled naphtha; but, in naphtha, expoſed to the air, it is ſoon oxidated, and an alkali which unites with the naphtha into a brown ſoap that collects round the globule, is formed. Potaſſium acts ſlowly on the concrete oils, as tallow, ſpermaceti, and wax, even when heated; coaly matter is depoſited, a little gas is evolved, and a ſoap is formed. On the fluid fixed oils the effects are ſimilar, but take place more ſlowly. With the aſſiſtance of heat, volatile oils are rapidly decompoſed by potaſſium; gas is evolved, and charcoal depoſited.

The metallic oxides, when heated in contact with potaſſium, are readily reduced. When a ſmall quantity of oxide of iron was heated with it, to a temperature approaching its point of diſtillation, a vivid action took place. Alkali, in gray metallic particles, which efferveſced in muriatic acid, appeared. The oxides of lead and tin were revived more rapidly, and with potaſſium in exceſs, an alloy was formed with the revived metal.

Potaſſium readily decompoſes flint glaſs and green glaſs, by a gentle heat. The metallic oxides are reduced, and the alkali formed diſſolves the glaſs. At a red heat, even the pureſt glaſs is acted on by potaſſium; the oxygen in the alkali of the glaſs ſeems to be divided between the potaſſium employed, and the potaſſium which is the baſe of the alkali in the glaſs, and thus effects an oxidation in the firſt degree.

Soda.—When pure ſoda was ſubjected in ſimilar circumſtances to the action of galvaniſm, ſimilar reſults were obtained as from potaſh; but the decompoſition required a more intenſe action in the battery, or it was neceſſary to have the alkali in thinner and ſmaller pieces. Potaſſium remained fluid at the temperature of the atmoſphere, at the time of its production; but the baſe obtained from ſoda, which was fluid in the degree of heat of the alkali during its formation, became ſolid on cooling, and exhibited the luſtre of ſilver. With a battery of 100 pairs of plates of ſix inches, in full activity, the decompoſition of pieces of ſoda of about 15 or 20 grains in weight only could be effected; and it was neceſſary alſo that the diſtance between the wires ſhould not exceed one-eighth or one-tenth of an inch. But when 250 pairs of plates were employed, highly charged for the decompoſition of ſoda, the globules often burnt at the moment of their formation, and ſometimes exploded and ſeparated into ſmaller globules, which darted rapidly through the air, in a ſtate of vivid combuſtion, producing a beautiful effect of continued jets of fire.

When the metallic baſe which is obtained from ſoda, and which Mr Davy has denominated *ſodium*, was expoſed to oxygen, it was converted into ſoda; and when this proceſs was conducted by ſtrongly heating the baſe in a given portion of oxygen, a rapid combuſtion with a brilliant white flame was produced, and the metallic globule was converted into a white ſolid maſs, which was found to be ſoda. The oxygen gas was abſorbed during the operation, and nothing was given out which affected the purity of the reſidual air.

The theory of the decompoſition of the alkalies is ſtated by Mr Davy in the following words. "As in all decompoſitions of compound ſubſtances which I had previouſly examined, at the ſame time that combuſtible baſes were developed at the negative ſurface in the electrical circuit, oxygen was produced, and evolved or carried into combination at the poſitive ſurface, it was reaſonable to conclude, that this ſubſtance was generated in a ſimilar manner by the electrical action of the alkali; and a number of experiments made above mercury, with the apparatus for excluding external air, proved that this was the caſe. When ſolid potaſh or ſoda, in its conducting ſtate, was included in glaſs tubes, furniſhed with electrified platina wires, the new ſubſtances were generated at the negative ſurfaces; the gas given out at the other ſurface proved, by the moſt delicate examination, to be pure oxygen; and, unleſs when exceſs of water was preſent, no gas was evolved from the negative ſurface.

For the purpoſe of determining the proportions of the elements of ſoda, Mr Davy made ſimilar experiments to thoſe by which he aſcertained the proportions of the baſe and oxygen of potaſh. By ſubjecting ſodium to combuſtion in oxygen gas, it appeared that 100 parts of ſoda are compoſed of 80 of metallic baſe, and 20 of oxygen; but the reſults of its oxidation by the decompoſition of water, indicated the proportions to be 23 of oxygen, and 77 of baſe. By taking the mean proportions, obtained from the reſults of the two ſets of experiments, the elements of ſoda may be eſtimated at 78.5 of metallic baſe, and 21.5 of oxygen.

Sodium, which remains ſolid at common temperatures, is white and opaque; and examined under a film of naphtha, has the luſtre and appearance of ſilver. It is very malleable, and ſofter than common metallic ſubſtances. With a ſlight preſſure it ſpreads into thin leaves, and a globule of one-tenth or one-twelfth of an inch in diameter, is eaſily ſpread over a ſurface of one-fourth of an inch; and different globules are eaſily made to adhere, and form one maſs by ſtrong preſſure. This property of welding which belongs to iron and platina at a white heat only, is not diminiſhed when ſodium is cooled to 32° Fahrenheit.

Sodium, like potaſſium, is a conductor of electricity and heat, and ſmall globules ſubjected to galvaniſm inflame and burn with bright exploſions. Sodium ſinks in naphtha of ſpecific gravity .861; but by mixing perfectly about 12 parts of naphtha, and five of oil of ſaſſafras, the ſodium remains at reſt in any part of the fluid. This makes its ſpecific gravity = about .9348, water being taken as 1. The particles of ſodium loſe their coheſion at 120° Fahrenheit. It becomes quite fluid at 180°, ſo that it readily fuſes under boiling naphtha. The temperature at which it is volatilized is not aſcertained, but it remains fixed in a ſtate of ignition at the point of fuſion of plate glaſs.

The chemical relations of ſodium are analogous to thoſe of potaſſium, but with ſome characteriſtic differences. Expoſed to the atmoſphere, it is immediately tarniſhed, and is gradually covered with a white cruſt, which is pure ſoda. It combines ſlowly with oxygen, and without any luminous appearance at common temperatures. When heated, the combination is more rapid, but no light is emitted till it acquire a temperature near that of ignition. The flame in oxygen gas is white, and it ſends forth bright ſparks, producing a very beautiful effect; in common air, the colour of the light is like that of the combuſtion of charcoal, but brighter. When ſodium was heated in hydrogen gas, it ſeemed to have no action on it.

Sodium burns vividly in oxymuriatic acid gas, giving out numerous ſparks of a bright red colour; a ſaline matter is produced, which is muriate of ſoda. When ſodium is thrown into water, it produces a violent effervеſcence with a loud hiſſing noiſe; it combines with the oxygen of the water to form ſoda, which is diſſolved, and its hydrogen is diſengaged. During the proceſs there is no luminous appearance; but when ſodium is thrown into hot water, a more violent decompoſition takes place. A few ſcintillations are obſerved at the ſurface of the water, which is owing to ſmall particles of the baſis which are thrown out of the water, heated to ſuch a degree as to burn in paſſing through the atmoſphere. But when a globule of ſodium is brought into contact with a ſmall particle of water, or with moiſtened paper, the heat produced is uſually ſufficient for its combuſtion, as in this caſe there is no medium to carry off the heat rapidly.

Sodium produces ſimilar effects with potaſſium when brought into contact with alcohol and ether. It acts with great energy on the ſtrong acids; with nitrous acid it produces a vivid inflammation, and with muriatic and ſulphuric acids, great heat, but no light, is generated. The effects of ſodium and potaſſium on the fixed and volatile oils, and naphtha, are quite analogous; but the appearances of the ſaponaceous compounds are ſomewhat different, the combinations with ſodium being of a darker colour, and apparently leſs ſoluble.

Sodium alſo exhibits two degrees of combination with oxygen; the firſt is of a deep brown colour, which is fluid when produced, and becomes a dark gray ſolid on cooling. By attracting oxygen from the air, or by the decompoſition of the water, it is converted into ſoda.

Sodium forms compounds with ſulphur and phoſphorus. In cloſe veſſels filled with the vapour of naphtha, it enters into combination with ſulphur, giving out during the proceſs a vivid light and heat, and often attended with exploſion, from the vaporization of a portion of ſulphur, and the diſengagement of ſulphurated hydrogen gas. The ſulphuret of ſodium is of a deep gray colour. In its combination with phoſphorus, the compound obtained has the appearance of lead, and by expoſure to the air, or by being ſubjected to combuſtion, the phoſphuret of ſodium is converted into phoſphate of ſoda.

Sodium forms compounds with the metals. In the proportion of one-fortieth with mercury, a compound is obtained, which is of the colour of ſilver, and remains ſolid; the combination is accompanied with conſiderable heat. Sodium forms an alloy with tin, without producing any change of colour, and it has ſome action upon lead and gold when heated; but in its ſtate of alloy it is ſoon converted into ſoda, by expoſure to the air, or by the action of water, which it decompoſes with diſengagement of hydrogen. The amalgam of mercury and ſodium ſeems to be capable of forming triple compounds with ſome other metals; and it would appear that iron and platina remain in combination with the mercury, after they are deprived of the ſodium by expoſure to the air. The ſame amalgam of ſodium and mercury likewiſe forms combinations with ſulphur; the triple compound thus obtained is of a dark gray colour.

Ammonia.—The chemical compoſition of ammonia has been many years conſidered as fully eſtabliſhed; but in the courſe of Mr Davy's experiments on the decompoſition of the fixed alkalies, it occurred to him that oxygen might alſo form one of the conſtituents of ammonia, and this he alſo proved by experiment. Charcoal carefully burnt, and deprived of moiſture, was ignited by a galvanic battery of 250 pairs of plates of ſix and four inches ſquare, in a ſmall quantity of pure ammoniacal gas, confined over mercury. A great expanſion of the gaſeous matter took place, and the white

GALVANISM

Plate DLXXVIII.

Fig. 1.

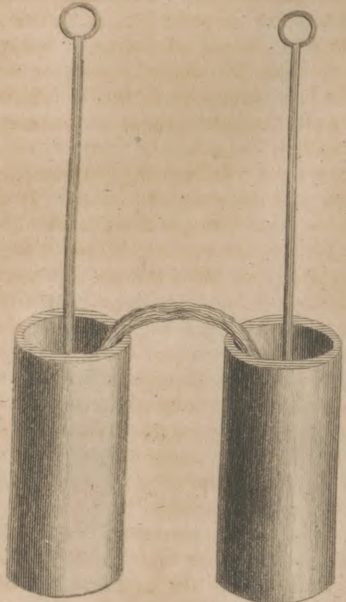


Fig. 2.

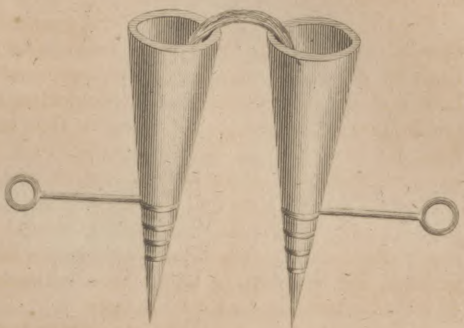


Fig. 3.

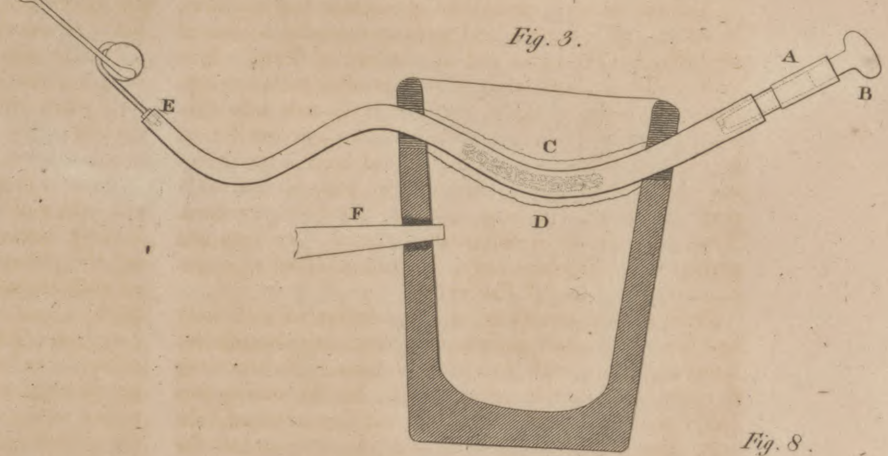


Fig. 5.

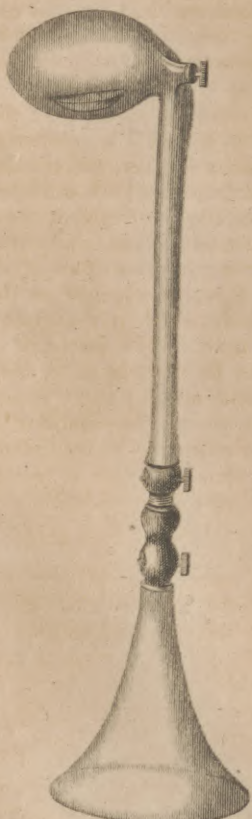
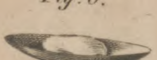


Fig. 8.

Fig. 4.

Fig. 7.

Fig. 6.



E. Mitchell sculp^t.

ſubſtance formed in the proceſs collected on the ſides of the glaſs tube. This matter efferveſced in diluted muriatic acid, ſo that the product was probably carbonate of ammonia. A more deciſive proof of ammonia containing oxygen as one of its elements, was obtained from another proceſs. Very pure ammoniacal gas was paſſed over iron wire ignited in a platina tube, and two curved glaſs tubes were ſo arranged as to be inſerted into a freezing mixture, and through one of theſe tubes the gas entered into the platina tube, to be conveyed through it by the other glaſs tube into an air-holder. The temperature of the air was 55°, and no ſenſible quantity of water was depoſited in the cooled glaſs tube, which tranſmitted the unchanged ammonia. But after being expoſed to heat, moiſture was very perceptible, and the gas appeared in the air-holder denſely clouded. This circumſtance appeared to eſtabliſh the formation of the water from the decompoſition of ammonia during the proceſs. But after the gas had been paſſed ſeveral times through the ignited tube, from one air-holder to the other, the iron wire was found ſuperficially converted into oxide, and had increaſed in weight $\frac{44}{100}$ of a grain. About four-tenths of a grain of water were collected from the cooled glaſs tubes by means of filtrating paper, and 33.8 cubic inches of gas were expanded into 55.3 cubic inches, and by detonation with oxygen it was found, that the hydrogen gas in theſe was to the nitrogen or azote as 3.2 to 1 in bulk.

Ammonia was farther ſubjected to experiment by taking the electric ſpark in it. In experiments of this kind it was underſtood that it is reſolved into hydrogen and azotic gaſes; but Mr Davy found, after obſerving ſeveral variations in the reſults, that the weight of the two gaſes obtained was leſs by about one-eleventh than the weight of the ammonia employed. He aſcribes this loſs to the oxygen of the alkali, which had probably combined with the wires of platina employed in the experiment, and had thus diſappeared. From theſe experiments he eſtimates the proportion of oxygen in ammonia at not leſs than 7 or 8 parts in 100; and as the gaſes evolved may contain more water than the gas decompoſed, the proportion may even be larger. By thus conſidering ammonia as a triple compound of azote, hydrogen, and oxygen, the phenomena of its production and decompoſition admit of an eaſy explanation. In all caſes in which ammonia is formed, oxygen exiſts along with its other elements, in the ſubſtances from the decompoſition of which it is obtained. In the decompoſition of ammonia, on the other hand, the oxygen, which forms one of its elements, may be abſtracted by the ſubſtance employed in its decompoſition, or it may enter into combination with portions of its hydrogen or azote.

But in the progreſs of inveſtigating the nature of ammonia, to which the attention of chemical philoſophers has been particularly directed, it appears that this alkali is analogous to the fixed alkalies in having a metallic baſe. The Swediſh chemiſts Berzelius and Pontin, placed mercury negatively electrified in the galvanic circle, in contact with ſolution of ammonia. By this action the mercury increaſed in volume, and after an expanſion of four or five times its former dimenſions, it became a ſoft ſolid. From this amalgam expoſed to the air, mercury and ammonia are reproduced, with the abſorption of oxygen; and when the amalgam is put into water it forms ammonia, with the evolution of hydrogen, and the re-appearance of the mercury in its metallic ſtate. Mr Davy repeated this experiment, and he found that to produce an amalgam, from 50 or 60 grains of mercury, in contact with a ſaturated ſolution of ammonia, required a conſiderable time, and that this amalgam changed conſiderably, even in the ſhort period that was neceſſary for removing it from the ſolution. Conceiving that the de-oxidation and combination with mercury might be more eaſily effected in its naſcent ſtate, he placed 50 grains of mercury in a cavity in muriate of ammonia. The muriate ſlightly moiſtened was placed on a plate of platina, and connected with the poſitive ſide of a large galvanic battery. The mercury was made negative by means of a platina wire; a ſtrong efferveſcence, with much heat, immediately took place; the globule of mercury in a few minutes enlarged to five times its former dimenſions. It had the appearance of amalgam of zinc. Metallic cryſtallizations ſhot from it as a centre round the body of ſalt. They had an arboreſcent appearance, often became coloured at their points of contact with the muriate, and when the connection was broken, rapidly diſappeared, while ammoniacal fumes were given out, and the mercury was reproduced. With a piece of carbonate of ammonia, ſimilar phenomena were exhibited. The amalgam was formed very rapidly; but when the galvanic action was powerful in this laſt caſe, a black matter appeared in the cavity, which was probably carbone, from the decompoſition of the carbonic acid.

Mr Davy conſidering the ſtrong attraction of potaſſium and ſodium for oxygen, was led to examine whether they produced any effect in the amalgamation of ammonia, independent of electricity. With this view he united ſmall portions of potaſſium and ſodium with mercury, and brought them into contact with moiſtened muriate of ammonia. An amalgam was formed, which rapidly increaſed to ſix or ſeven times its volume, and the compound ſeemed to contain a larger proportion of ammoniacal baſe than that obtained by electricity. It appears, too, that a portion of the metallic baſe employed to effect the de-oxidation always remained in combination with the compound, ſo that it was not a pure amalgam. The following are the properties of the amalgam from ammonia, obtained by means of galvaniſm.

When this amalgam is formed at the temperature of 70° or 80°, it is in the ſtate of a ſoft ſolid, of the conſiſtence of butter; at 32° it becomes firmer, and aſſumes a cryſtallized form, in which ſmall facets appear, which ſeem to be cubical. The amalgam of potaſſium cryſtallizes in cubes, as beautiful, and in ſome caſes as large, as thoſe of biſmuth. The ſpecific gravity of the amalgam is leſs than three, water being one. When the amalgam is thrown into water, a quantity of hydrogen equal to half its bulk, is evolved, and the water becomes a weak ſolution of ammonia. The amalgam being confined in a given portion of air, the air increaſes in bulk, and the mercury is revived. Ammoniacal gas equal to $1\frac{1}{2}$ or $1\frac{2}{3}$ths of the volume of the amalgam, is produced, and oxygen equal to one-ſeventh or one-eighth of the ammonia, diſappears. When the amalgam is thrown into muriatic acid gas, it becomes inſtantly coated with muriate of ammonia, and a ſmall portion of hydrogen is evolved. In ſulphuric acid it becomes coated with ſulphate of ammonia and ſulphur.

Mr Davy attempted, by various methods, to preſerve the amalgam, in the hope of ſubmitting it to diſtillation, for the purpoſe of obtaining the metallic baſe of the ammonia, which was united to the mercury, in a ſeparate form. But as it is extremely difficult to free mercury, after being once moiſtened entirely from water, he did not ſucceed in this attempt. In wiping the amalgam carefully with bibulous paper, part of the ammonia was regenerated, and in paſſing it through fine linen, with the view of ſeparating the moiſture, a complete decompoſition was effected, and the mercury was revived.

The quantity of the baſe of ammonia combined with 60 grains of quickſilver, appears not to exceed $\frac{1}{200}$ of a grain, and the quantity of oxygen required for this is not more than $\frac{1}{1000}$ of a grain of water, which might be ſupplied by merely breathing upon the amalgam. Mr Davy made various other experiments, with the view of aſcertaining the nature and properties of the amalgam of ammonia; but for an account of theſe we muſt refer to the paper itſelf. And he obſerves, that the more theſe properties are conſidered, the more extraordinary will they appear. Mercury, by combination with about $\frac{1}{12000}$ of its weight of new matter, becomes ſolid, and yet has its ſpecific gravity reduced from 13.5 to leſs than 3, retaining at the ſame time its metallic characters, its colour, luſtre, opacity, and conducting powers, undiminiſhed. Can it then be conceived, Mr Davy aſks, that a ſubſtance which forms with mercury ſo perfect an amalgam, ſhould not be metallic in its own nature? This ſubſtance he denominates *ammonium*. On what then, it is farther aſked, do the metallic properties of ammonium depend? Are hydrogen and nitrogen both metals in the gaſeous ſtate, at the uſual temperature of the atmoſphere; bodies of the ſame character, as zinc and mercury in the ſtate of ignition? Or are theſe gaſes in their common form oxides which become metallized by de-oxidation? Or are they to be conſidered as ſimple bodies, not metallic in their own nature, but capable of compoſing a metal when deprived of oxygen, and becoming an alkali with the addition of oxygen?

In the farther proſecution of the experiments relative to the nature of ammonia, Mr Davy employed potaſſium. He brought ammonia into contact with about twice its weight of potaſſium at common temperatures; but excepting a ſlight diminution in the volume of the gas, and the metal loſing its luſtre and becoming white, no other effects were produced. The white cruſt when examined, proved to be potaſh, and a ſmall portion of hydrogen was found in the ammonia, but not more than equal in volume to the metal. When the potaſſium was heated in the gas, by means of a ſpirit lamp applied to
Fig. 5. the bottom of the retort, (fig. 5.) the colour of the cruſt changed from white to bright azure, and gradually to bright blue, green, and dark olive. The cruſt and the metal then fuſed together. This proceſs is attended with effervescence; and the cruſt paſſing off to the ſides, exhibits the ſhining ſurface of the potaſſium. When heated a ſecond time, it ſwells conſiderably, becomes porous, cryſtallized, and of a beautiful azure tint. A gas is evolved during this operation, which gives the ſame diminution by detonation with oxygen, as hydrogen, and ammonia diſappears.

It has been obſerved that the proportion of ammonia which loſes its elaſtic form, varies according as the gas employed contains more or leſs moiſture. Thus, in ammonia ſaturated with water at 63° Fahrenheit, potaſſium cauſed the diſappearance of twelve and a half cubical inches of ammonia; but in ammonia deprived of moiſture, by expoſure for two days to potaſh that had been ignited, the ſame quantity of potaſſium occaſioned the diſappearance of 16 cubical inches; but whatever were the degrees of moiſture of the gas, the quantity of hydrogen generated always appeared equal for equal quantities of metal; and according to the French chemiſts, the portions are ſtated to have been the ſame as would have reſulted from the action of water upon potaſſium. But in Mr Davy's experiments, the proportions were rather leſs. In one, conducted with great care, eight grains of potaſſium generated, by their action upon water, eight and a half cubical inches of hydrogen gas; and eight grains of potaſſium from the ſame maſs, by their operation upon ammonia, produced $8\frac{1}{8}$ cubical inches of hydrogen gas. This difference, although inconſiderable, Mr Davy found always to take place.

In Mr Davy's experiments on the action of potaſſium on ammonia, he employed retorts of plate glaſs. The potaſſium was faſtened upon trays of platina or iron, which were introduced into the glaſs retorts furniſhed with ſtop-cocks. The retorts were exhauſted by an air-pump, then filled with hydrogen, exhauſted a ſecond time, and afterwards filled with ammonia. (See fig. 5. and 6.). Fig. 5, and 6.

The following are the properties of the ſubſtance obtained from the action of ammonia on potaſſium. 1. It is cryſtallized, and preſents irregular facets, which are extremely dark, and in colour and luſtre not unlike the green oxide of iron; it is opaque when examined in large maſſes, but is ſemitranſparent in thin films, and appears of a bright brown colour by tranſmitted light. 2. It is fuſible at a heat a little above that of boiling water, and if heated much higher, emits globules of gas. 3. It appears to be conſiderably heavier than water, for it ſinks rapidly in oil of ſaſſafras. 4. It is a non-conductor of electricity. 5. When it is melted in oxygen gas, it burns with great vividneſs, emitting bright ſparks. Oxygen is abſorbed, nitrogen is emitted, and potaſh, which from its great fuſibility ſeems to contain water, is formed. 6. When brought into contact with water, it acts upon it with much energy, produces heat, and often inflammation, and evolves ammonia. When thrown upon water, it diſappears with a hiſſing noiſe, and globules from it often move in a ſtate of ignition upon the ſurface of the water. It rapidly effervesces and deliqueſces in air, but can be preſerved under naphtha, in which, however, it ſoftens ſlowly, and ſeems partially to diſſolve. When it is plunged under water filling an inverted jar, by means of a proper tube, it inſtantly diſappears with effervescence, and the non-abſorbable elaſtic fluid liberated is found to be hydrogen gas.

It is found that the weight of this ſubſtance is greater than that of the potaſſium from which it is formed; and from this it is concluded, that part of the ammonia, or of its elements, enters into its compoſition. When this ſubſtance is decompoſed by heat, nitrogen and hydrogen gaſes, with a portion of ammonia, are given out. It appears, however, that the production of the ammonia is in proportion to the moiſture admitted, and when the moiſture is conſiderable, the whole product is ammonia. When this ſubſtance is expoſed to heat, a matter remains, which even by increaſing the heat, is no farther changed. On this reſiduum water acts violently, and with efferveſcence, from the evolution of hydrogen gas. Ammonia and potaſh are at the ſame time reproduced. Mr Davy's concluſion from theſe experiments is, that the ſubſtance formed by the action of ammonia on potaſſium is a compound of the latter with a ſmall proportion of oxygen and nitrogen; and as it is found that the quantity of hydrogen given out during its formation is nearly equal to the hydrogen contained in the ammonia, it follows that neither hydrogen nor the ammonia itſelf can be ſuppoſed to enter into its compoſition.

In proſecuting this inveſtigation, Mr Davy made various experiments, and whether the ſubſtance was acted on by water, expoſed to the action of oxygen, or decompoſed by heat, it was found, contrary to expectation, that the quantity of nitrogen evolved during its decompoſition was much leſs than in proportion to the quantity of ammonia which had diſappeared in its formation. In one experiment, in which the decompoſition was effected by heat, the gaſeous product was examined, and was found to be partly potaſh, and partly potaſſium; but it afforded no traces of ammonia, when acted on by water, which is a proof that it retained no nitrogen. In another experiment, 11 cubic inches of ammonia, or 2.05 grains, were decompoſed by potaſſium. The product was 3.6 cubic inches of nitrogen, equal to 1.06 grain; 16 cubic inches of hydrogen, equal to .382 grain; and there was added to the potaſſium a quantity of oxygen equal to .6 grain. Theſe products taken together amount to 2.04 grains, which is nearly equal to the quantity of ammonia employed; but this quantity of ammonia, if the proportions of its elements be eſtimated, from its decompoſition by electricity, would have yielded 5.5 cubic inches of nitrogen, equal to 1.6 grain, and only 14 cubic inches equal to .33; and allowing the ſeparation of oxygen in this proceſs in water, it cannot be eſtimated at more than .11 or .12; and hence, if the analyſis of ammonia by electricity come near to accuracy, there is in this proceſs a conſiderable loſs of nitrogen, and the production of oxygen and hydrogen.

How, ſays Mr Davy, can theſe extraordinary reſults be explained? The decompoſition and compoſition of nitrogen ſeem proved, and one of its elements appears to be oxygen; but what is the other element? Is the gas that appears to poſſeſs the properties of hydrogen a new ſpecies of inflammable aeriform ſubſtance? Or has nitrogen a metallic baſis, which alloys with the iron or platina? Or is water alike the ponderable matter of nitrogen, hydrogen, and oxygen? Or is nitrogen a compound of hydrogen, with a larger proportion of oxygen than exiſts in water? Of theſe important queſtions, Mr Davy adds, the two firſt ſeem the leaſt likely to be anſwered in the affirmative, from the correſpondence between the weight of the ammonia decompoſed, and the products, ſuppoſing them to be known ſubſtances.

In concluding this ſubject, we muſt obſerve, that it ſtill remains in a conſiderable degree of obſcurity. It ſeems, however, to be aſcertained, that the baſe of ammonia is of a metallic nature, which muſt be derived, either from the nitrogen or the hydrogen, or from both, or perhaps theſe ſubſtances are only different forms of combination of the elementary baſe. Or if nitrogen be ſuppoſed to be an oxide of hydrogen, then hydrogen in its gaſeous form is either a metallic ſubſtance, or has a metallic baſe, which latter enters into combination with the mercury employed in the decompoſition of ammonia.

Decompoſition of the Earths.

From the reſults of the experiments on potaſh and ſoda, which Mr Davy obtained, he was led to entertain the ſtrongeſt hopes of being able to effect the decompoſition both of the alkaline and common earths; and the phenomena which took place in the firſt imperfect trials made upon theſe bodies countenanced the ideas, that had obtained ſince the earlieſt periods of chemiſtry, of their being metallic in their nature.

The earths, like the fixed alkalies, are non-conductors of electricity; but the fixed alkalies become conductors by fuſion: the infuſible nature of the earths, however, rendered it impoſſible to operate upon them in this ſtate: the ſtrong affinity of their baſes for oxygen, made it unavailing, to act upon them in ſolution in water; and the only methods that proved ſucceſsful, were thoſe of operating upon them by electricity in ſome of their combinations, or of combining them at the moment of their decompoſition by electricity in metallic alloys, ſo as to obtain evidences of their nature and properties. To render the experiments upon the earths ſatisfactory, a more powerful battery will be required, than Mr Davy has a proſpect of ſeeing very ſoon conſtructed; he therefore prefers the imputation of having publiſhed unfiniſhed labours, to that of having concealed any new facts.

Barytes, ſtrontites, and lime, ſlightly moiſtened, were electrified by iron wires under naphtha, by the ſame methods, and with the ſame powers, as thoſe employed for the decompoſition of the fixed alkalies. In theſe caſes gas was copiouſly evolved, which was inflammable; and the earths, where in contact with the negative metallic wires, became dark coloured and exhibited ſmall points, having a metallic luſtre, which, when expoſed to air, gradually became white: they became white likewiſe when plunged under water; and when examined in this experiment with a magnifier, a greeniſh powder ſeemed to ſeparate from them, and ſmall globules of gas were diſengaged.

In theſe experiments there was great reaſon to believe that the earths had been decompoſed; and that their baſes had combined with the iron, ſo as to form alloys decompoſable by the oxygen of the air or water; but the indiſtinctneſs of the effect, and the complicated circumſtances required for producing it, were ſuch as to compel Mr Davy to form other plans of operation.

Mr Davy bearing in mind the ſtrong attraction of potaſſium for oxygen, was induced to try whether this body might not detach the oxygen from the earths, in the ſame manner as charcoal decompoſes the common metallic oxides. He heated potaſſium in contact with dry pure lime barytes, ſtrontites, and magneſia, in tubes of plate-glaſs; but as he was obliged to uſe very ſmall quantities, and as he could not raiſe the heat to ignition without fuſing the glaſs, he obtained no good reſults in this manner. The potaſſium appeared to act upon the earths and on the glaſs, and dark brown ſubſtances were obtained, which evolved gas from water; but no diſtinct metallic globules could be procured: from theſe, and other like circumſtances, it ſeemed probable, that though potaſſium may partially deoxigenate the earths, yet its affinity for oxygen, at leaſt at the temperature employed, is not ſufficient to effect their decompoſition. Mr Davy, having made mixtures of dry potaſh in exceſs and dry barytes, lime, ſtrontites, and magneſia, brought them into fuſion, and acted upon them in the galvanic circuit in the ſame manner as he employed for obtaining the metals of the alkalies. He expected that the potaſſium and the metals of the earths might be deoxigenated at the ſame time, and enter into combination in alloy.

In this way of operating, the reſults were more diſtinct than in the laſt: metallic ſubſtances appeared leſs fuſible than potaſſium, which burned the inſtant after they had formed, and which by burning produced a mixture of potaſh and the earth employed. An attempt was made to form the metallic ſubſtances under naphtha, but without much ſucceſs. To produce the reſult at all, required a charge by the action of nitric acid, which the ſtate of the batteries would not often allow of; and the metal was generated only in very minute films, which could not be detached by fuſion, and which were inſtantly deſtroyed by expoſure to air.

Mr Davy had found in his reſearches upon potaſſium, that when a mixture of potaſh and the oxide of mercury, tin, or lead, was electrified in the galvanic circuit, the decompoſition was very rapid, and an amalgam, or an alloy of potaſſium, was obtained; the attraction between the common metals and potaſſium apparently accelerating the ſeparation of the oxygen. The idea that a ſimilar kind of action might aſſiſt the decompoſition of the alkaline earths, induced him to electrify mixtures of theſe bodies and the oxide of tin, of iron, of lead, of ſilver, and of mercury; and theſe operations were far more ſatisfactory than any of the others.

A mixture of two-thirds of barytes, and one third of oxide of ſilver very ſlightly moiſtened, was electrified by iron wires; an efferveſcence took place at both points of contact, and a minute quantity of a ſubſtance, poſſeſſing the whiteneſs of ſilver, formed at the negative point. When the iron wire to which this ſubſtance adhered, was plunged into water containing a little alum in ſolution, gas was diſengaged, which proved to be hydrogen; and white clouds, which were found to be ſulphate of barytes, deſcended from the point of the wire.

A mixture of barytes and red oxide of mercury, in the ſame proportions, was electrified in the ſame manner. A ſmall maſs of ſolid amalgam adhered to the negative wire, which evidently contained a ſubſtance, that produced barytes by expoſure to the air, with the abſorption of oxygen; and which occaſioned the evolution of hydrogen from water, leaving pure mercury, and producing a ſolution of barytes.

Mixtures of lime, ſtrontites, magneſia, and red oxide of mercury, treated in the ſame manner, gave ſimilar amalgams, from which the alkaline earths were regenerated by the action of air or water, with like phenomena; but the quantities of metallic ſubſtances obtained were exceedingly minute; they appeared as mere ſuperficial formations ſurrounding the point of the wire, nor did they increaſe after the firſt few minutes of electrization, even when the proceſs was carried on for ſome hours.

Theſe experiments were at firſt made when the batteries were in bad order; but were afterwards reſumed with a new and much more powerful apparatus, conſtructed in the laboratory of the Royal Inſtitution, and conſiſting of five hundred pairs of double plates of ſix inches ſquare.

When Mr Davy attempted to obtain amalgams with this apparatus, the tranſmitting wires being of platina, of about $\frac{1}{40}$ of an inch diameter, the heat generated was ſo great as to burn both the mercury and baſis of the amalgam at the moment of its formation; and when, by extending the ſurfaces of the conductors, this power of ignition was modified, yet ſtill the amalgam was only procured in thin films, and globules ſufficiently large to ſubmit to diſtillation could not be procured. When the tranſmitting wires were of iron of the ſame thickneſs, the iron acquired the temperature of ignition, and combined with the baſes of the earths in preference to the mercury; and metallic alloys of a dark grey colour were obtained, which acted on water with the evolution of hydrogen, and were converted into oxide of iron and alkaline earths.

While Mr Davy was engaged in theſe experiments, he received a letter from Profeſſor Berzelius of Stockholm, who ſtated that in conjunction with Dr Pontin, he had ſucceeded in decompoſing barytes and lime, by negatively electrifying mercury in contact with them, and that in this way he had obtained amalgams of the metals of theſe earths.

Mr Davy immediately repeated theſe operations with perfect ſucceſs; a globule of mercury, electrified by the power of the battery of 500, weakly charged, was made to act upon a ſurface of ſlightly moiſtened barytes, fixed upon a plate of platina. The mercury gradually became leſs fluid, and after a few minutes was found covered with a white film of barytes, and when the amalgam was thrown into water, hydrogen was diſengaged, the mercury remained free, and a ſolution of barytes was formed.

The reſult with lime, as theſe gentlemen had ſtated, was preciſely analogous. Strontites and magneſia were decompoſed in the ſame manner.

From ſtrontites the expected reſult ſoon took place; but from magneſia, in the firſt trials, no amalgam could be procured. By continuing the proceſs, however, for a longer time, and keeping the earth continually moiſt, at laſt a combination of the baſis with mercury was obtained, which ſlowly produced magneſia by abſorbing oxygen from the air, or by the action of water.

Mr Davy found that all theſe amalgams might be preſerved for a conſiderable period under naphtha. In length of time, however, they became covered with a white cruſt under this fluid. In water, the amalgam of barytes was moſt rapidly decompoſed; that of ſtrontites and that of lime next in order: but the amalgam from magneſia, as might be expected from the weak affinity of the earth for water, very ſlowly changed. When a little ſulphuric acid was added to the water, however, the evolution of hydrogen, and the production and ſolution of magneſia, were exceedingly rapid, and the mercury ſoon remained free.

Mr Davy believed, that one reaſon why magneſia was leſs eaſy to metallize, than the other alkaline earths,

was

was owing to its inſolubility in water, which would prevent it from being preſented in the naſcent ſtate, detached from its ſolution at the negative ſurface.

He then made the experiment, uſing moiſtened ſulphate of magneſia inſtead of the pure earth; and the amalgam was much ſooner obtained. Here the magneſia was attracted from the ſulphuric acid, and probably deoxigenated and combined with the quickſilver at the ſame inſtant.

The amalgams of the other baſes of the alkaline earths could be obtained in the ſame manner from their ſaline compounds: muriate and ſulphate of lime, the muriate of ſtrontites and barytes, and nitrate of barytes, were decompoſed by the ſame means as the other earths. The earths, ſeparated at the deoxigenating ſurface, theſe ſeemed inſtantly to undergo decompoſition, and, ſeized upon by the mercury, were in ſome meaſure defended from the action of air, and from the contact of water, and preſerved by their ſtrong attraction for this metal.

In attempting to procure the metals of the alkaline earths, the latter were ſlightly moiſtened, and mixed with one-third of red oxide of mercury; the mixture was placed on a plate of platina; a cavity was made in the upper part of it to receive a globule of mercury, of from 50 to 60 grains in weight; the whole was covered by a film of naphtha, and the plate was made poſitive, and the mercury negative, by a proper communication with the battery of five hundred.

The amalgams obtained in this way were diſtilled in tubes of plate-glaſs, or in ſome caſes in tubes of common glaſs. Theſe tubes were bent in the middle, and the extremities were enlarged and rendered globular by blowing, ſo as to ſerve the purpoſes of a retort and receiver. The tube, after the amalgam had been introduced, was filled with naphtha, which was afterwards expelled, by boiling, through a ſmall orifice in the end correſponding to the receiver, which was hermetically ſealed when the tube contained nothing but the vapour of naphtha, and the amalgam. It was found immediately that the mercury roſe pure by diſtillation from the amalgam, and it was very eaſy to ſeparate a part of it; but to produce a complete decompoſition was very difficult, as nearly a red heat was required for the purpoſe, and as at a red heat the baſes of the earths inſtantly acted upon the glaſs, and became oxigenated. When the tube was large in proportion to the quantity of amalgam uſed, the vapour of the naphtha furniſhed oxygen ſufficient to deſtroy part of the baſes: and when a ſmall tube was employed, it was difficult to heat the part uſed as a retort ſufficient to drive off the whole of the mercury from the baſes, without raiſing too highly the temperature of the part ſerving for the receiver, ſo as to burſt the tube.

In conſequence of theſe difficulties, in a multitude of trials, only a very few ſucceſsful reſults were obtained; and in no caſe could our author be abſolutely certain, that there was not a minute portion of mercury ſtill in combination with the metals of the earths.

In the beſt reſult obtained from the diſtillation of the amalgam of barytes, the reſiduum appeared as a white metal, of the colour of ſilver. It was fixed at all common temperatures, but became fluid at a heat below redneſs, and did not riſe in vapour when heated to redneſs, in a tube of plate-glaſs, but acted violently upon the glaſs, producing a black maſs, which ſeemed to contain barytes, and a fixed alkaline baſis, in the firſt degree of oxigenation. When expoſed to air, it rapidly tarniſhed, and fell into a white powder, which was barytes. When this proceſs was conducted in a ſmall portion of air, the oxygen was abſorbed and the nitrogen remained unaltered; when a portion of it was introduced into water, it acted upon it with great violence and ſunk to the bottom, producing in it barytes; and hydrogen was generated. From the minuteneſs of the quantities obtained, neither its phyſical nor chemical qualities could be examined correctly. It ſunk rapidly in water, and even in ſulphuric acid, though ſurrounded by globules of hydrogen, equal to two or three times its volume; from which it ſeems probable, that it cannot be leſs than four or five times as heavy as water. It flattened by preſſure, but required a conſiderable force to produce this effect.

The metal from ſtrontites ſunk in ſulphuric acid, and exhibited the ſame characters as that from barytes, except in producing ſtrontites by oxidation.

The metal from lime, Mr Davy has never been able to examine, either when expoſed to air, or when under naphtha. In the caſe in which he was able to diſtil the quickſilver from it to the greateſt extent, the tube unfortunately broke, while warm, and at the moment that the air entered, the metal, which had the colour and luſtre of ſilver, inſtantly took fire, and burned with an intenſe white light into quicklime.

The metal from magneſia ſeemed to act upon the glaſs, even before the whole of the quickſilver was diſtilled from it. In an experiment in which the proceſs was ſtopped before the mercury was entirely driven off, it appeared as a ſolid; having the ſame whiteneſs and luſtre as the metals of the other earths. It ſunk rapidly in water, though ſurrounded by globules of gas producing magneſia, and quickly changed in air, becoming covered with a white cruſt, and falling into a fine powder, which proved to be magneſia.

In ſeveral caſes in which amalgams of the metals were obtained, containing only a ſmall quantity of mercury, they were expoſed to air on a delicate balance, and it was always found, that, during the converſion of metal into earth, there was a conſiderable increaſe of weight.

Mr Davy endeavoured to aſcertain the proportions of oxygen and baſis in barytes and ſtrontites, by heating amalgams of them in tubes filled with oxygen, but without ſucceſs. He ſatisfied himſelf, however, that when the metals of the earths were burned in a ſmall quantity of air, they abſorbed oxygen, gained weight in the proceſs, and were in the highly cauſtic or unſlaked ſtate; for they produced ſtrong heat by the contact of water, and did not effervesce during their ſolution in acids.

The evidence for the compoſition of the alkaline earths is then of the ſame kind as that for the compoſition of the common metallic oxides; and the principles of their decompoſition are preciſely ſimilar, the inflammable matters in all caſes ſeparating at the negative ſurface in the galvanic circuit, and the oxygen at the poſitive ſurface.

Mr Davy has denominated the metals obtained from the alkaline earths, *barium*, *ſtrontium*, *calcium*, and *magnium*.

In attempting the decompoſition of the other earths, Mr

Mr Davy was leſs fortunate in obtaining diſtinct reſults; and he obſerves that the methods which have uſually proved ſucceſsful, as well as ſome others, failed. When alumina was ſubjected to the action of electricity, it was in a ſtate of fuſion with potaſh. In this proceſs metallic globules were produced, but they conſiſted chiefly of the baſe of the alkali. Some appearances, however, ſhewed, that the alumina itſelf was decompoſed; for when ſoda was employed, the metallic product obtained was leſs fuſible than ſodium itſelf, and when it was acted on by water, it produced ſoda and a white powder. When potaſh was fuſed with the alumina, and ſubjected to galvanic action, the metallic product decompoſed water with great rapidity, and the ſolution obtained depoſited alumina by the action of an acid. When potaſſium in the ſtate of amalgam, with one-third of mercury, in contact with alumina, was negatively electrified under naphtha, and after the proceſs had been continued for ſome time, the amalgam was added to water, a decompoſition took place, and a ſolution was obtained, which produced a cloudineſs on the addition of an acid; but all theſe reſults are to be conſidered as very imperfect evidence of the decompoſition of alumina.

Mr Davy was ſtill leſs ſucceſsful in attempting the decompoſition of ſilica, partly from its inſolubility, and partly from its being ſcarcely, if at all, affected with electricity, when diffuſed in water, and placed in the galvanic circuit; but by following the ſame proceſſes as in his experiments on alumina, ſome indications of decompoſition appeared. When ſilica was fuſed with ſix parts of potaſh, and was placed in fuſion in the galvanic circuit, metallic matter was obtained, from which, by expoſure to the air, or by dropping it into water, a minute quantity of ſilica was reproduced. When potaſſium, amalgamated with one-third of mercury, and in contact with ſilica, was negatively electrified, he obtained a ſimilar reſult; but in none of the experiments could the product obtained be conſidered as the pure baſe of the earth.

The earths of zirconia and glucina were alſo ſubjected to the action of galvaniſm, by proceſſes ſimilar to thoſe which have now been deſcribed, and in both there were ſome indications of decompoſition; but the reſults were not ſo perfect as to lead to any certain concluſion reſpecting their nature.

Decompoſition of Sulphur and Phoſphorus.

Sulphur.—Sulphur, which had formerly been conſidered as a ſimple ſubſtance, appears, from the experiments of ſome of the French chemiſts, and particularly thoſe of Berthollet junior, to be a compound of ſulphur and hydrogen. The latter chemiſt, in his experiments to inveſtigate the nature of this ſubſtance, cauſed ſulphur to paſs through a coated glaſs tube, which was heated to whiteneſs; ſome indications of ſulphurated hydrogen were obtained. He then formed metallic ſulphurets, as of iron, copper, and mercury, and in theſe proceſſes, which were performed in an earthen retort with great care, ſulphurated hydrogen gas was alſo obtained. Water in the ſtate of vapour being paſſed over ſulphur in fuſion, cauſed the evolution of ſulphurated hydrogen; the water was not decompoſed, for no trace of acid could be obſerved. It ſeemed only to have effected the diſengagement of hydrogen from the ſulphur.

Mr Davy, in the courſe of his experiments in galvaniſm, ſubjected ſulphur to the action of that power. The ſulphur which he employed was ſublimed in a retort, filled with azotic gas, and it was kept hot till the commencement of the experiment. The reaſon of this preliminary proceſs was, to avoid any uncertainty which might ariſe from water abſorbed by the ſulphur. The ſulphur introduced into a curved tube, fig. 7. which was furniſhed with wires of platina A and B, the upper wire A being hermetically ſealed into the end of the tube, was then placed in the galvanic circuit of a battery of 500 pairs of plates of ſix inches, in a ſtate of great activity. A very intenſe action followed, accompanied by great heat and a brilliant light. The ſulphur ſoon entered into ebullition, and gave out a great quantity of elaſtic fluid, a good deal of which was permanent. The ſulphur itſelf aſſumed a deep red brown colour. The gas obtained was ſulphurated hydrogen. In another experiment made on 200 grains of ſulphur, the amount of ſulphurated hydrogen obtained was equal to more than five times the volume of the ſulphur. A conſiderable action was obſerved to have taken place on the wires of platina; and the ſulphur, at its point of contact with the wires, reddened moiſt litmus paper. When ſulphur and potaſſium are heated together, a very powerful action takes place. Sulphurated hydrogen is diſengaged with very intenſe heat and light. From theſe experiments the concluſion ſeems fair and obvious, that hydrogen exiſts in ſulphur, for a ſubſtance, as Mr Davy obſerves, which can be produced from it in ſuch abundance, is not to be conſidered merely as an accidental ingredient.

Fig. 7.

But as it is admitted that ſulphurated hydrogen contains oxygen, Mr Davy contends that oxygen is to be regarded as one of the conſtituents of ſulphur. In this opinion he is ſupported by experiment. He heated potaſſium in ſulphurated hydrogen gas, from which moiſture had been as much as poſſible abſtracted, by muriate of lime. The potaſſium took fire, and burnt with a brilliant flame. When four grains of potaſſium were heated in 20 cubic inches of gas, the quantity of gas diminiſhed only about 2½ cubic inches; but the properties of the gas were totally changed. A ſmall portion only of it was abſorbed by water, and the remainder was hydrogen, holding in ſolution a minute portion of ſulphur. Some ſulphur was obſerved on the ſides of the retort, and a ſolid matter was formed, which on the ſurface was of a red colour, like ſulphuret of potaſh, but internally dark gray, like ſulphuret of potaſſium. By ſubjecting this ſubſtance to the action of muriatic acid, ſulphurated hydrogen gas was obtained, but the proportion was leſs than would have been given out, had the potaſſium been in combination with pure combuſtible matter. From this Mr Davy concludes, that there is a principle in ſulphurated hydrogen which is capable of deſtroying partially the inflammability of potaſſium, and of producing upon it all the effects of oxygen. As ſulphurated hydrogen is obtained by heating ſulphur ſtrongly in hydrogen gas, Mr Davy introduced four grains of ſulphur in a glaſs retort, containing about 20 cubical inches of hydrogen, and by means of a ſpirit lamp, he raiſed the heat nearly to redneſs. No perceptible change took place in the volume of the gas after the proceſs. The ſublimed ſulphur was unchanged in its properties, and about three cubical inches of unelaſtic fluid, abſorbable by water, reddening litmus, and having all the properties of ſulphurated hydrogen gas, were formed. Suppoſing then

ſulphurated

ſulphurated hydrogen to be conſtituted by ſulphur diſſolved in its unchanged ſtate in hydrogen, and admit the exiſtence of oxygen in this gas, its exiſtence muſt likewiſe be allowed in ſulphur. From theſe experiments Mr Davy thinks it not unreaſonable to aſſume, that ſulphur in its common ſtate is a compound of ſmall quantities of oxygen and hydrogen, with a large quantity of a baſe, which produces the acids of ſulphur in combuſtion; and as this baſis, it is added, poſſeſſes ſtrong attractions for other bodies, it will probably be very difficult to obtain it in its uncombined ſtate.

Sulphur combines readily with potaſſium, when brought into contact in tubes filled with the vapour of naphtha; heat and light are rapidly evolved during the combination, and a gray ſubſtance like artificial ſulphuret of iron, is produced. The ſulphurated hydrogen in ſmall quantity is formed at the moment of combination, the hydrogen of which, it is ſuppoſed, is derived from the ſulphur. The ſulphuret of potaſſium readily inflames, and when expoſed to the air, it is gradually oxidated, and converted into ſulphate of potaſh.

Sulphur alſo enters into combination with ſodium, accompanied alſo with the evolution of heat and light. An exploſion ſometimes takes place, which is owing to the volatilization of a portion of ſulphur, and the diſengagement of ſulphurated hydrogen gas. The ſulphuret of ſodium is of a deep gray colour.

Phoſphorus.—Mr Davy ſubjected phoſphorus to ſimilar experiments, and he found that the ſame analogies are applicable to this combuſtible. Common electrical ſparks tranſmitted through phoſphorus produce no evolution of permanent gas; but when acted upon by the ſame galvanic battery, and in the ſame circumſtances as the ſulphur, a conſiderable evolution of gas was effected, and the phoſphorus became of a deep red brown colour. The gas was phoſphorated hydrogen; and in an experiment continued for ſome hours, the quantity evolved was four times the volume of the phoſphorus. The light by the galvanic ſpark was at firſt a brilliant yellow, and afterwards orange.

Three grains of potaſſium were heated in 16 cubical inches of phoſphorated hydrogen. As the fuſion was effected, the retort was filled with white fumes, and a reddiſh ſubſtance was depoſited upon the upper part and ſides; the heat was applied for ſome minutes, but no inflammation took place. When the retort cooled, the abſorption was leſs than a cubical inch; the potaſſium externally was of a deep brown, and internally of a lead colour. The reſidual gas ſeemed to contain in ſolution a little phoſphorus, but it had not the property of ſpontaneous inflammation. While the phoſphuret was acted upon over mercury by a ſolution of muriatic acid, it gave out only $1\frac{3}{4}$ cubical inch of phoſphorated hydrogen.

One grain of potaſſium, and one of phoſphorus, were fuſed together. In combining, a very vivid light and intenſe ignition were produced; $\frac{1}{10}$ of a cubical inch of phoſphorated hydrogen was evolved, and the phoſphuret, with diluted muriatic acid over mercury, gave out $\frac{3}{10}$ of a cubical inch of phoſphorated hydrogen. In another experiment with one grain of potaſſium, and three of phoſphorus, nearly one-fourth of a cubical inch of phoſphorated hydrogen was obtained; but the compound yielded by muriatic acid, only $\frac{1}{10}$ of a cubical inch.

From theſe experiments it is concluded, that phoſphorated hydrogen contains a minute proportion of oxygen, and conſequently that the ſame element enters into the compoſition of phoſphorus. The deficiency of phoſphorated hydrogen in the laſt experiment can only be referred to the ſupply of oxygen to the potaſſium from the phoſphorus; and the quantity of phoſphorated hydrogen produced in the experiment with equal parts of potaſſium and phoſphorus, is much leſs than could be expected, if the potaſſium and phoſphorus conſiſted merely of pure combuſtible matter.

Mr Davy alſo inſtituted a ſet of intereſting experiments on the ſtates of the carbonaceous principle in plumbago, charcoal, and the diamond, and the reſults of theſe are detailed in the ſame memoir; but for an account of them we muſt refer to the paper itſelf.

Decompoſition of Boracic, Fluoric, and Muriatic acids.

The properties of boracic, fluoric, and muriatic acids, many of which are quite analogous to thoſe of other acids whoſe elements have been diſcovered, have led chemiſts to conclude that oxygen is alſo the acidifying principle in the former; but the ſeparate exiſtence or nature of the baſe of theſe three acids was, till the late reſearches of galvaniſm were inſtituted, utterly unknown. The inveſtigation of the nature of theſe ſubſtances has been proſecuted by Mr Davy, and ſome of the French chemiſts; and of their experiments we ſhall now give a very ſhort account.

Boracic acid.—When boracic acid was moiſtened with water, and expoſed between two ſurfaces of platina, and then ſubjected to the battery of 500 plates, an olive brown matter formed on the negative ſurface, and, increaſing in thickneſs, appeared at laſt almoſt black. This ſubſtance was permanent in water, but it diſſolved and efferveſced in warm nitrous acid. Heated to redneſs on the platina, it burnt ſlowly, and gave off white fumes, which reddened moiſtened litmus paper. A black maſs remained, which through a magnifier appeared vitreous, and ſeemed to contain a fixed acid. The inference drawn from this experiment is, that the acid was decompoſed, and again by the latter proceſs reproduced.

When equal weights of potaſſium and boracic acid were heated together in a green glaſs tube, which had been exhauſted, after being twice filled with hydrogen gas, an intenſe ignition, with vivid inflammation, where the potaſſium was in contact with the boracic acid, took place, even before the temperature approached near to a red heat. When the acid had been heated to whiteneſs, before being introduced into the tube, and powdered and uſed while yet warm, the quantity of gas which was hydrogen, given out in the operation, did not exceed twice the volume of the acid. In this mode of conducting the experiment, 12 or 14 grains of each of the two ſubſtances only could be employed, on account of the intenſe heat and conſequent fuſion of the glaſs tube with larger proportions. Mr Davy found in ſeveral experiments, in which he employed equal parts of acid and potaſſium, that a great proportion of the former remained undecompoſed, and he aſcertained that twenty grains of potaſſium had their inflammability deſtroyed by eight grains of boracic acid.

To collect the ſubſtances formed in the proceſs, metallic tubes with ſtop-cocks, and exhauſted, after being filled with hydrogen, were employed. With tubes of braſs or copper, a dull red heat only, but with iron

tubes,

tubes, a white heat was applied; and in all caſes the acid was decompoſed with the ſame reſults. The ſubſtance obtained from the iron tube was in ſome parts of a dark olive colour, and in others almoſt black. It did not efferveſce with warm water, but was rapidly acted upon by it. The ſolutions obtained conſiſted of ſubborate of potaſh, and potaſh.

The following are the properties of the ſubſtance obtained in the decompoſition of boracic acid by means of proceſſes conducted in braſs tubes, which afforded it in largeſt proportion. To this ſubſtance Mr Davy has given the name of *boracium*, which, as it is produced in the manner now deſcribed, is in the form of a pulverulent maſs of the darkeſt ſhades of olive; it is opaque, very friable; the powder does not ſcratch glaſs, and is a non-conductor of electricity. Dried at 100° or 120°, it gives off moiſture, by decreaſing the temperature; and when heated in the atmoſphere, takes fire at a temperature below the boiling point of olive oil, emitting a red light, and ſparks like charcoal. When excluded from air, and ſubjected to a white heat in a platina tube, exhauſted after being filled with hydrogen, it remains unchanged, excepting in becoming a little darker, and acquiring a greater ſpecific gravity.

Boracium introduced into a retort filled with oxygen gas, and heated by a ſpirit lamp, throws off vivid ſcintillations like thoſe of the combuſtion of the bark of charcoal, and the maſs gives out a brilliant light. A ſublimate appears, which is boracic acid; it becomes coated with a vitreous ſubſtance, which is alſo found to be the ſame acid. When this is waſhed off, the black reſiduum requires a greater heat, but it is alſo inflamed, and converted into boracic acid. When boracium is brought into contact with oxymuriatic acid gas, at common temperatures, it immediately takes fire, and burns with a brilliant white light, coating the inſide of the veſſel with a white ſubſtance, which is boracic acid. Boracium heated to redneſs with hydrogen or nitrogen, became of a darker colour, and gave out a little moiſture, but remained otherwiſe unchanged. Thrown into concentrated nitric acid, it rendered it bright red; nitrous gas was produced and abſorbed, but no rapid ſolution took place till the acid was heated, when the boracium diſappeared with efferveſcence, and the evolution of nitrous gas, and the fluid yielded boracic acid. The action of boracium on ſulphuric and muriatic acids was not remarkable. It combined with the fixed alkalies, both by fuſion and aqueous ſolution, and formed pale olive-coloured compounds, which by muriatic acid were precipitated of a dark colour. When fuſed with ſulphur, it diſſolved ſlowly, and the ſulphur became of an olive colour. Its action with phoſphorus in the ſame circumſtances was ſtill feebler, but it communicated a ſhade of pale green.

From the experiments now detailed, it appears that boracium obtained by means of potaſſium, is different from any other known ſpecies of matter, and ſeems to be the ſame as that obtained from boracic acid by electricity. According to the reſult of experiments made by Mr Davy, boracic acid is compoſed of one part of boracium, and about 1.8 of oxygen; and ſuppoſing the dark reſidual ſubſtance to be an oxide, it conſiſts of 4.7 of boracium, and 1.55 of oxygen.

For an account of the experiments of Gay Luſſac and Thenard, in inveſtigating the nature of boracic acid, ſee Jour. de Phyſique, tom. lxvii. or Nichol. Jour. xxiii. 260.

Fluoric acid.—According to the experiments of Mr Davy, potaſſium, when heated in fluoric acid gas, undergoes combuſtion, and a great abſorption of the gas takes place. In other experiments he found, that when fluoric acid gas, procured in contact with glaſs, is introduced into a plate glaſs retort, exhauſted after being filled with hydrogen gas, white fumes appear from the action of the potaſſium, which loſes its ſplendour, and becomes coloured with a gray cruſt. The fumes are more copious when the bottom of the retort is gently heated. The volume of the gas examined at this time appears to be a little increaſed, with the addition of hydrogen; and when the temperature is raiſed nearly to the point of ſublimation of the potaſſium, the metal riſes through the cruſt, becomes firſt of a copper colour, and then inflames and burns with a brilliant red light. After this combuſtion, the fluoric acid is either wholly or partially deſtroyed, according as the quantity of potaſſium is great or ſmall; and a maſs of a chocolate colour is found in the bottom of the retort; the ſides and the top are lined with a ſublimate, which is partly chocolate, and partly of a yellow colour. When the reſidual gas is waſhed with water, mixed with oxygen gas, and expoſed to the action of an electrical ſpark, it detonates, and affords a diminution in the ſame way as hydrogen gas.

In one experiment with 19 cubical inches of fluoric acid gas, and ten grains and a half of potaſſium, 14 cubical inches of the gas diſappeared, and about two and a quarter of hydrogen gas were produced. The gas had not been artificially dried; little ſublimate was produced, but the whole of the bottom of the retort was covered with a brown cruſt. When this maſs was examined with a magnifier, it ſeemed to conſiſt of different kinds of matter. It did not conduct electricity; it efferveſced violently in water, with the evolution of an inflammable gas, which had ſomewhat of the odour of phoſphorated hydrogen. Part of the maſs heated in the air burnt ſlowly, and was converted into a white ſaline matter. It alſo burnt with difficulty in heated oxygen gas, but it abſorbed a portion that required nearly a red heat. The light emitted reſembled that from the combuſtion of liver of ſulphur. Chocolate coloured particles were found floating in the water, acted on by a portion of the maſs, and when the ſolid matter was ſeparated by the filter, the fluid was found to contain fluate of potaſh and potaſh. The ſolid reſiduum was heated in a ſmall glaſs retort filled with oxygen gas; it burnt before reaching a red heat, and became white. Oxygen was abſorbed, and acid matter produced. The remainder had the properties of the ſubſtance formed from fluoric acid gas, holding ſiliceous earth in ſolution by the action of water.

"The decompoſition of the fluoric acid, Mr Davy obſerves, by potaſſium, ſeems analogous to that of the acids of ſulphur and phoſphorus. In neither of theſe caſes are the pure baſes, or even the baſes in their common form, evolved; but new compounds reſult, and in one caſe, ſulphurets and ſulphites, and in the other phoſphurets and phoſphites of potaſh, are generated."

In another experiment Mr Davy attempted the decompoſition of fluoric acid gas, which was perfectly dry, and free from ſiliceous earth, by mixing 100 grs. of of dry boracic acid, and 200 grains of fluor ſpar. The mixture was introduced into the bottom of an iron tube, having a ſtop-cock and tube of ſafety attached. The tube was inſerted horizontally in a forge, and 20 grains of potaſſium in an iron tray were placed in that part of it where the heat was only of a dull red. The bottom of the tube was raiſed to a white heat, and the acid, as it was generated, was acted upon by the heated potaſſium. The reſult obtained was a ſubſtance in ſome parts black, and in others of a dark brown colour. It did not efferveſce with water, and when lixiviated, afforded a dark brown combuſtible maſs which did not conduct electricity, and, when burnt in oxygen gas, afforded boracic and fluoric acids. This ſubſtance did not inflame ſpontaneouſly in oxymuriatic acid gas; but it efferveſced violently, and diſſolved in nitric acid. Mr Davy thinks that this ſubſtance is a compound of the olive-coloured oxide of boracium, and an oxide of the baſe of fluoric acid; but he had not examined its properties particularly.

Muriatic acid.—Many conjectures have been offered with regard to the nature and conſtitution of muriatic acid, and many attempts have been made to effect its decompoſition. Mr Davy has extended his reſearches to this ſubſtance, and has proſecuted the inveſtigation with his uſual ardour. It is ſtill, however, to be regretted, that his ſucceſs has not been commenſurate with his ingenuity and induſtry. Some have ſuppoſed, that the baſe of muriatic acid is hydrogen, while others contend that the baſe is a compound of hydrogen and nitrogen.

The reſult of Mr Davy's firſt experiments in this inquiry ſhowed, that the water alone in combination with the muriatic acid is decompoſed, and that this elaſtic fluid contains a larger proportion of water than is uſually ſuſpected; and from various experiments he concludes, that muriatic acid gas, in its common ſtate, is combined with at leaſt one-third of its weight of water. In the proſecution of his reſearches, therefore, his object was to obtain the muriatic acid free from water. With this view he heated dry muriate of lime, mixed both with phoſphoric acid, and dry boracic acid, in tubes of porcelain and of iron, and employed the blaſt of an excellent forge; but by none of theſe methods was any gas obtained, till a little moiſture was added to the mixture, and then muriatic acid was given out in ſuch quantity as almoſt to produce exploſions. In diſtilling the liquor of Libavius, or the fuming muriate of tin, which contains dry muriatic acid, with ſulphur and with phoſphorus, no ſeparation of the acid took place; but with the addition of water, muriatic acid gas was evolved with great heat and violence. By diſtilling mixtures of corroſive ſublimate and ſulphur, and of calomel and ſulphur in their common ſtates, muriatic acid gas was evolved; but when theſe ſubſtances were dried by a gentle heat, the quantity of gas obtained was greatly diminiſhed. Mr Davy, and alſo the French chemiſts, endeavoured to procure dry muriatic acid by the diſtillation of a mixture of calomel and phoſphorus. The reſult obtained is conſidered as a compound of muriatic acid, phoſphorus, and oxygen. In Mr Davy's experiments, the product was more copious when corroſive ſublimate was employed. With the ſame view of procuring dry muriatic acid gas, he expoſed phoſphorus to the action of oxymuriatic acid gas, in the hope that in the oxidation of the phoſphorus, the whole of the moiſture would be abſorbed; but the examination of the reſult ſhowed, that no muriatic acid gas had been evolved during the proceſs, ſo that the muriatic acid which had diſappeared, muſt exiſt, either in the white ſublimate which had collected in the top of the retort, or in a limpid fluid which had formed in its neck. When the ſublimate was expoſed to the air, it emitted fumes of muriatic acid, and when brought into contact with water, muriatic acid gas was evolved, and phoſphoric and muriatic acids remained in ſolution in the water. Mr Davy regards this white ſublimate as a combination of phoſphoric and muriatic acids in their dry ſtates. The limpid fluid was of a pale greeniſh yellow colour; it rapidly diſappeared on expoſure to the air, emitting denſe white fumes, which had a ſtrong ſmell, differing a little from that of muriatic acid. Mr Davy thinks that this is a compound of phoſphoric and muriatic acids, both free from water.

Mr Davy made other experiments, for the purpoſe of procuring muriatic acid in its uncombined ſtate, but with no better ſucceſs. He then tried the effects of potaſſium introduced into the fluid generated by the action of phoſphorus on corroſive ſublimate; but ſuch was the violent action of the ſubſtances operated upon, that the apparatus was generally deſtroyed, and he was thus precluded from examining the reſults. But for a particular detail of the experiments, we muſt refer to the memoir itſelf; and for the extended account of Mr Davy's inveſtigations on this curious and intereſting ſubject, of which we have given as comprehenſive a view as our limits would permit, ſee Phil. Tranſ. 1807, 1808, and 1809.

ZINNIA, a genus of plants of the claſs *ſyngeneſia*, and in the natural ſyſtem arranged under the 49th order, *Compoſitæ*. See BOTANY *Index*.

ZINZENDORFF, NICHOLAS LEWIS, COUNT, was the noted founder of the German religious ſect called *Moravians*, or *Herrnhuters*, or, as they pretend, the reſtorer of that ſociety. From his own narrative it appears, that when he came of age in 1721, his thoughts were wholly bent on gathering together a little ſociety of believers, among whom he might live, and who ſhould entirely employ themſelves in exerciſes of devotion under him. He accordingly purchaſed an eſtate at Bertholſdorff in Upper Luſatia, where, being joined by ſome followers, he gave the curacy of the village to a perſon of his own complexion; and Bertholſdorff ſoon became talked of for a new mode of piety. One Chriſtian David, a carpenter, brought a few proſelytes from Moravia: they began a new town about half a league from the village, where Count Zinzendorff fixed his reſidence among them, and whither great numbers of Moravians flocked and eſtabliſhed themſelves under his protection: ſo that in 1732 their number amounted to 600. An adjacent hill, called the *Huthberg*, gave occaſion to theſe coloniſts to call their new ſettlement *Huth des Herrn*, and afterwards *Herrnhuth*; which may be interpreted "The guard or protection of the Lord:" and from this the whole ſect have taken their name. The count ſpared neither pains nor art to propagate his opinions; he went himſelf all over Europe, and at leaſt twice to America; and ſent miſſionaries throughout the world. Count Zinzendorff died in 1760. Thoſe who wiſh to know more of the Moravian tenets may conſult Rimius's account of them, tranſlated in 1753. See UNITED BRETHREN.

ZISCA, JOHN, a famous general of the forces of the Huſſites, in the 15th century, was a gentleman educated at the court of Bohemia, in the reign of Wenceſlaus. He entered very young into the army, and after diſtinguiſhing himſelf on ſeveral occaſions, loſt an eye in a battle, whence he was called *Ziſca*, or *One-eyed*. At length the Reformation, begun by John Huſs, ſpreading through almoſt all Bohemia, Ziſca placed himſelf at the head of the Huſſites, and had ſoon under his command a body of 40,000 men. With this army he gained ſeveral victories over thoſe of the Romiſh religion, who carried on a kind of cruſade againſt them, and built a town in an advantageous ſituation, to which he gave the name of *Tabor*; whence the Huſſites were afterwards called *Taborites*. Ziſca loſt his other eye by an arrow at the ſiege of the city of Rubi; but this did not prevent his continuing the war, his fighting battles, and gaining ſeveral great victories, among which was that of Auſig on the Elbe, in which 9000 of the enemy were left dead on the field. The emperor Sigiſmund, alarmed at his progreſs, cauſed very advantageous propoſals to be offered to him; which he readily accepted, and ſet out to meet Sigiſmund, but died on the road. He ordered that his body ſhould be left a prey to the birds and wild beaſts; and that a drum ſhould be made of his ſkin, being perſuaded that the enemy would fly as ſoon as they heard the ſound. It is added, that the Huſſites executed his will; and that the news of this order made ſuch an impreſſion on the diſturbed imaginations of the German Papiſts, that in many battles they actually fled at the beat of the drum with the utmoſt precipitation, leaving their baggage and artillery behind them.

ZINZIBER, or ZINGIBER. See AMOMUM, BOTANY and MATERIA MEDICA *Index*.

ZION, or SION, in *Ancient Geography*, a very famous mountain, ſtanding on the north ſide of the city of Jeruſalem, (Pſal. xlvii. 2.); containing the upper city, built by King David; and where ſtood the royal palace, (Joſephus). A part of Zion, ſituated at its extremity, was called *Millo*, of or in the city of David, (2 Chron. xxxii. 5.) Modern travellers, who have been upon the ſpot, ſay, that Zion is the whole of the mountain, on which Jeruſalem ſtands at this day, though not to the extent in which it anciently ſtood on the ſame mountain, as appears Pſal. ix. 12. 15. lxv. 1. lxxxvi. 2, 3. Iſ. lxii. 1. It is ſwelled into ſeveral eminences or tops; as Moriah, Acra Bezetha, and Zion a particular eminence or mount, and Zion Proper, &c. encompaſſed on three ſides, eaſt, weſt, and ſouth, with one continued very deep and ſteep valley; by means of which it was impregnable on theſe three ſides, and always attacked and taken, according to Joſephus, by the enemy on the north ſide, where Mount Zion became level, and the vales of Gihon and Jehoſophat gradually loſe themſelves. This deep and ſteep valley inconteſtably conſtitutes the compaſs of the old Jeruſalem on thoſe three ſides, as plainly appears to any perſon who has been upon the ſpot. On that particular top of the mount called *Zion* ſtood the fortreſs of the Jebuſites; which being afterwards taken by David, came to be called the *City of David*, where he had his royal reſidence and kept his court. That part of the valley which lay to the eaſt was called *Jehoſophat's*, having Mount Olivet lying beyond it; that to the ſouth *Gehinnon*; and that to the weſt, *Gihon*, from cognominal mountains lying beyond them. At the weſt end of Gihon, without the city, ſtood Golgotha or Calvary. The pretended Golgotha, ſhown at this day within the walls, is the ſpurious brat of intereſted and fraudulent monks, (Korte). There is another *Zion*, the ſame with HERMON.

ZION, or *Zion College*. See LONDON, n° 76.

ZIPH, or SIPH, in *Ancient Geography*, the name of a wilderneſs or deſert in the tribe of Judah, where David was fugitive; lying to the ſouth-eaſt of Hebron; ſo called from Ziph or Siph, a twofold town in this tribe; the one more to the ſouth towards Idumea, on the confines of Eleutheropolis, (Jerome); the other eight miles to the eaſt of Hebron, towards the Dead ſea, inclining ſouthwards, becauſe near Mount Carmel. Here was a mountain, mentioned 1 Sam. xxiii. 14. in which David abode, ſaid by Jerome to be rugged, diſmal, and always overcaſt. *Ziphim*, *Ziphæi*, or *Ziphenſes*, the inhabitants of Ziph, ver. 19.

ZIRCHNITZER-SEE, otherwiſe called the *Lake of Czirknitz*, in Carniola, is about one German or four Engliſh miles in length, and half as much in breadth, contains three beautiful iſlands, and is encompaſſed at ſome diſtance with mountains and foreſts. But what is moſt remarkable is, that it diſappears generally once a-year, about St John's or St James's day, running off through holes or pits in the bottom; ſometimes it diſappears twice or thrice a-year, and ſometimes even in winter if the weather be dry. On the other hand, it has been known to continue two or three years without running off. Of the holes or pits, there are five much larger than the reſt, each of which ſucceſſively, when the water runs off, ſtands empty five days; ſo that the whole lake becomes dry in 25. As ſoon as the beginning of the ebb is obſerved, the fiſhing in the pits begins, which belongs to five ſeigniories. The fiſh, which are carp, tench, pike, eels, and two other ſorts called *ſchleien* and *ruten*, are caught by laying nets over the holes. Mr Keyſler tells us, that upon the ringing of a bell at Zirknitz, when the waters begin to fall, the peaſants, both men and women, run to the pools quite naked.

ZIRCON, a mineral ſubſtance containing a peculiar earth. See MINERALOGY *Index*.

ZIRCONIA, a peculiar earth. See CHEMISTRY *Index*.

ZIZANIA, a genus of plants of the claſs monœcia; and in the natural ſyſtem arranged under the 4th order, *Gramina*. See BOTANY *Index*.

ZODIAC, a broad circle, whoſe middle is the ecliptic, and its extremes two circles parallel thereto, at ſuch a diſtance from it as to bound or comprehend the excurſions of the ſun and planets, (ſee ASTRONOMY). It is a curious enough fact, that the ſolar diviſion of the Indian zodiac is the ſame in ſubſtance with that of the Greeks, and yet that it has not been borrowed either from the Greeks or the Arabians. The identity, or at leaſt ſtriking ſimilarity, of the diviſion, is univerſally known; and M. Montucla has endeavoured to prove, that the Bramins received it from the Arabs. His opinion, we believe, has been very generally admitted; but in the ſecond volume of the Aſiatic Reſearches, the accompliſhed preſident Sir William Jones has proved unanſwerably, that neither of thoſe nations borrowed that diviſion from the other; that it has been known among the Hindoos from time immemorial; and that it was probably invented by the firſt progenitors of that race, whom he conſiders as the moſt ancient of mankind, before their diſperſion. The queſtion is not of importance ſufficiently general, ſtraitened as we are by the limits preſcribed us, for our entering into the diſpute; but we think it our duty to mention it, that our aſtronomical readers, if they think it worth their while, may have recourſe to the original writers for further information.

ZOEGEA, a genus of plants of the claſs ſyngeneſia, See BOTANY *Index*.

ZONE, in *Geography* and *Aſtronomy*, a diviſion of the terraqueous globe with reſpect to the different degrees of heat found in the different parts thereof. The zones are denominated torrid, frigid, and temperate. The torrid zone is a band, ſurrounding the terraqueous globe, and terminated by the two tropics. Its breadth is 46° 58′. The equator, running through the middle of it, divides it into two equal parts, each containing 23° 29′. The ancients imagined the torrid zone uninhabitable. The temperate zones are contained between the tropics and the polar circles. The breadth of each is 43° 2′. The frigid zones are ſegments of the ſurface of the earth, terminated, one by the antarctic, and the other by the artic circle. The breadth of each is 46° 58′.

ZOOLOGY, is that part of natural hiſtory which relates to *animals*. See NATURAL HISTORY.

ZOOPHYTES. The name ZOOPHYTES, *Zoophyta* (i. e. *animal plants*, from ζωον, *animal*, and φυλον, *plant*), has been long appropriated to a numerous aſſemblage of marine or aqueous productions, which have puzzled the ingenuity of naturaliſts to aſcertain their place in the chain of nature's works, and which have been alternately ranked among vegetable and animal, and ſometimes even among mineral ſubſtances. At length, however, they ſeem, by general conſent, to have been conſigned over to the animal kingdom, and, with the addition of ſeveral tribes from the Linnæan orders of *Inteſtina*, *Molluſca*, and *Infuſoria*, have, by Cuvier and his colleagues of the French ſchool, been elevated to the rank of a ſeparate claſs. See HELMINTHOLOGY, N° 11.

In the Linnæan ſyſtem, the zoophytes of earlier modern naturaliſts conſtitute the 4th order of the claſs VERMES, and as ſuch have been enumerated under HELMINTHOLOGY; but as the circumſcribed limits of that article did not admit of our deſcribing or figuring many ſpecies, we ſhall now as far as poſſible ſupply that deficiency by ſelecting a few of the moſt curious or intereſting ſpecies of the Linnæan zoophytes; and we ſhall take this opportunity of making a few obſervations on ſome of the genera to which they belong.

Tubipora Muſica.
Plate DLXXIX.
Fig. 1. & 2.

Figs. 1. and 2. repreſent the TUBIPORA *muſica*, *crimſon tubipore*, or *organ coral;* one of the moſt elegant of theſe ſingular productions. This ſpecies is diſtinguiſhed from its congeners by *having the tubes connected into faſciculæ* or *bundles, and ſeparated from each other by tranſverſe membranous partitions.* The whole maſs conſiſts of upright parallel tubes, riſing over each other by ſtages, ſomething like the cells of a honeycomb. Theſe tubes vary in height from half an inch to an inch; and are from one-tenth to one-eighth of an inch in diameter. Examined internally, they appear to contain a ſmaller tube divided at certain diſtances by radiated partitions (ſee fig. 2.), by means of which the tranſverſe *ſepta* ſometimes communicate with each other. Theſe tranſverſe *ſepta* are of unequal heights. The colour of the maſs is a deep purple, or a rich crimſon. The ſize of the maſs varies conſiderably; but ſpecimens have been obtained of from a foot to three feet in diameter. It is found abundantly in the Pacific ocean, and on the ſhores of ſome of the iſlands in the Indian ſea.

In its recent ſtate it is covered with a mucous or gelatinous ſubſtance, which pervades the whole maſs and enters within each tube. The inhabiting animal is not certainly aſcertained, but ſeems to be allied to the *nereis* tribe.

Madrepora fungites.
Fig. 3. & 4.

Figs. 3. and 4. exhibit two views of the MADREPORA *fungites*, or *muſhroom madrepore*. This body ſo exactly reſembles a muſhroom, that it has very commonly been regarded as that vegetable in a ſtate of petrifaction; but recent obſervations ſeem to prove that it is formed by ſmall animals like *meduſæ*. The convex ſide of this madrepore is conical, ſometimes obtuſely pointed, and exhibits on its ſurface thoſe ſtellated pores which form the diſtinguiſhing character of the genus, while the concave ſurface is divided into numerous radiated furrows ſo as to repreſent the *gills* of a muſhroom. When firſt obtained, it is of a delicate white colour, eſpecially on the concave part, but it ſoon acquires a brown or yellowiſh tinge. It is found of various ſizes, from an inch to ſix inches in diameter. It is met with chiefly in the Indian ocean and Red ſea.

Iſis hippuris.
Fig. 5. & 6.

At fig. 5. is repreſented that elegant coral called by Linnæus ISIS *hippuris*, the *black and white jointed coral* of Ellis. The ſpecific character of this coral is that it *is compoſed of white ſtriated joints united by black junctures;* but this ſtructure is not viſible till after the coral has been freed from a whitiſh ſoft ſpongy part, with which the branches are covered in their natural ſtate. See fig. 6. It is found chiefly in the Indian ſeas, and varies in height from a few inches to nearly two feet.

Antipathes myriophylla.
Plate DLXXX.
Fig. 7. & 8.

Fig. 7. repreſents the ANTIPATHES *myriophylla*, *yarrow antipathes*, or *ſea-yarrow*, of its natural ſize; while fig. 8. ſhews one of the pinnæ conſiderably magnified.

This is one of thoſe zoophytes which in their habit and appearance almoſt exactly reſemble ſome of the vegetable tribes, and hence have received the names of *ſea-heath*, *ſea-cypreſs*, *ſea-fennel*, &c. From their colour they are uſually denominated *black coral*. This ſpecies, though one of the ſmalleſt, is not the leaſt elegant of the tribe. It conſiſts of numerous branches, compoſed of very ſlender pinnæ arranged in no certain order. The whole coral is ſeldom above a foot in height, and rough on its outer ſurface. This alſo is a native of the Indian ocean, being found more eſpecially on the coaſts of the Molucca iſlands, and is ſometimes met with in the Great South ſea.

Gorgonia nobilis.
Fig. 9. & 10.

Fig. 9. exhibits a ſpecimen of *red coral*, the ISIS *nobilis* of Linné, and GORGONIA *nobilis* of later naturaliſts. This ſubſtance, though now nearly exploded from the *materia medica*, will ſtill retain a place in our cabinets for its intrinſic beauty and elegant appearance; but when examined on its native beds, or ſoon after being fiſhed up, it ſhews a very different ſurface from that under which we uſually ſee it. Fig. 9. repreſents it as prepared for ſale by being deprived of its fleſhy animal *bark* or coating, but retaining the ſtriated appearance which marks its ſpecific character; but fig. 10. exhibits a piece of it in its natural ſtate, with polypes extruded from the fleſhy coat, and ſhewing ſtill more diſtinctly at the extremities the ſtreaks below.

Red coral is found in large beds or reefs in ſeveral parts of the Mediterranean ſea, and coral fiſheries are eſtabliſhed on the coaſts and near the iſlands. A fiſhery of this kind in the ſtraits of Meſſina is minutely deſcribed by Spallanzani in his *Travels in the two Sicilies*, vol. iv. To tear the coral from the rocks they make uſe of a machine compoſed of two beams tied acroſs each other, and furniſhed with a leaden weight to ſink them, and a quantity of looſe hemp and ſeveral ſtrong nets to entangle the branches of the coral. To this machine is attached a ſtrong rope, which is held by the fiſhers, and ſerves both to direct the net and to draw it up when the coral is entangled. Several boats go in company, each containing eight men, and the fiſhery laſts from April to July. The quantity collected every year amounts on an average to twelve Sicilian quintals, each equal to 250 pounds Troy, and each pound uſually ſells for about four ſhillings and ſixpence. They do not fiſh on the ſame bank oftener than once in ten years, as this time is deemed neceſſary for the coral to acquire its full ſize and vigour.

Gorgonia ceratophyta.
Fig. 11.

Another beautiful ſpecies of gorgonia, the GORGONIA *ceratophyta*, is figured at fig. 11. This is diſtinguiſhed by its *dichotomous flattiſh ſtem, and aſcending branches*. The outer fleſh is of a purpliſh colour, and the branches are furniſhed with two rows of ſcattered pores from which the polypi appear. It is found in the Mediterranean, and ſometimes on the eaſtern coaſts of America.

Alcyonium gorgonoides.
Fig. 12.

Nearly allied to the gorgoniæ is the ſpecies of alcyonium repreſented at fig. 12. This is the ALCYONIUM *gorgonoides* of Gmelin. It is of a cinereous colour, of a ſandy fleſhy conſiſtence, having radiated warty cellules. It is found on the northern coaſt of South America, eſpecially near the iſland of Curaçoa.

The zoophytes which naturaliſts diſtinguiſh by the generic name alcyonium, ſometimes form independent bodies of a rounded form, ſuch as thoſe called the *ſea-orange*, *ſea-fig*, &c.; or cover the ſurface of ſhells and other marine bodies like a kind of bark. Their internal part or baſe is friable, and, when dried, appears to be compoſed of fine fibres, which are either longitudinal, as in the preſent caſe, diverging, or circular. This baſe is covered with a ſoft cruſt, that in drying aſſumes a leathery conſiſtence, and is pierced with numerous little cells inhabited by polypi. In ſome ſpecies theſe cells are diſperſed over the whole ſurface of the coral, while in others they are confined to particular ſpots or tubercles. They are all inhabitants of the ocean, where they are uſually fixed to rocks or other ſolid bodies.

Spongia tubuloſa.
Plate DLXXXI.
Fig. 13.

In the article HELMINTHOLOGY we have ſufficiently treated of the nature and properties of the ſponges, and have there mentioned particularly the common or *officinal* ſponge. At fig. 13. is repreſented a more curious ſpecies, the SP. tubuloſa or *fiſtularis*, the *tubular* or *pipey ſponge*. This conſiſts of ſimple upright, attenuated, rigid tubes, tuberculated on the outer ſurface, which is of a black colour. It is found in the ſeas that waſh the coaſts of America.

Fluſtra arenoſa.
Fig. 14.

The *fluſtræ* are a tribe of inſignificant zoophytes, which ſeem ſcarcely entitled to the rank which they hold in the animal creation. They are formed of a congeries of ſuperficial cells, placed cloſe together, like thoſe of a honeycomb, but generally occupying only a ſingle ſurface. Sometimes this ſubſtance forms a coating to ſome other marine body, at others it is unattached and forms a floating foliaceous maſs or *mat*. The ſpecies repreſented at fig. 14. is one of the moſt curious, and is deſcribed by Ellis under the name of *Engliſh ſea-mat*, called in the *Linnæan Tranſactions*, vol. v. FLUSTRA *arenoſa*. It is compoſed of ſandy particles agglutinated together with ſlime, and in ſhape reſembles the fore part of a horſe's hoof. It is very friable, and ſo thin as to be eaſily broken. Theſe *fluſtræ* are found abundantly on the coaſt of Kent, and about Holy-head on the Welſh coaſt.

Sertularia ſetacea.
Fig. 15. & 16.

Fig. 15. repreſents a ſpecimen of SERTULARIA *ſetacea*, the *ſmall ſea-briſtle coralline* of Ellis, of its natural ſize; and fig. 16. ſhews the ſame ſpecimen conſiderably magnified. This ſpecies is diſtinguiſhed by being *ſimply pinnated, with bent alternate pinnæ, furniſhed with very remote proceſſes growing only on one ſide, and oblong axillary ovaries*. It is one of the ſmalleſt and moſt delicate of the tribe, ſeldom exceeding an inch and a half in height. It is very common, and is found on the Britiſh coaſts.

None of the zoophytes bear a nearer reſemblance to vegetables than the *ſertulariæ*. Their creeping roots, their branched ſtem, and tufts of ſeeming flowers (the polypine proceſſes) give them all the air of plants. Hence they were long conſidered as *ſea-moſſes*, and deſcribed by botaniſts under that name. See Ray's *Synopſis*, p. 38. and 39. When attentively examined, however, their animal nature will ſcarcely be diſputed. Externally they are compoſed of a horny ſubſtance, perfectly tranſparent, and through this may be diſtinguiſhed the animal ſubſtance traverſing the centre of the ſtem and branches like the pith of a plant, and appearing externally as little knots or protuberances in the form of tentaculated polypes. Theſe extraneous polypes are conſidered by Cuvier, (*Tableau Elementaire*, p. 768.) not as diſtinct animals, but only as parts of the ſame animal which conſtitutes the ſole inhabitant of the ſertularia. Theſe zoophytes adhere to rocks, ſhells, &c. by creeping roots, and appear to propagate by means of eggs. They are among the moſt common of this claſs of animated beings.

Pennatula phoſphorea.
Fig. 17. & 18.

The PENNATULÆ or *Sea-pens* conſtitute a very curious tribe of zoophytes, which are completely locomotive, and ſwim in the manner of fiſhes. They conſiſt of an internal bone or rather horny ſubſtance, covered with a ſenſible fleſhy coat. Their lower extremity is ſimple like the barrel of a quill, while the upper extremity is expanded into a flattened part, that is generally compoſed of pinnæ like the barbs of a quill, though it is ſometimes merely a ſimple expanded maſs furniſhed with polypine proceſſes.

Fig. 17. repreſents one of the moſt common *ſea-pens* properly ſo called, the PENNATULA *phoſphorea*, *phoſphoreſcent pennatula*, of its natural ſize. It has *a fleſhy ſtem, a rough middle part, and imbricated pinnules*. The pinnæ are furniſhed on one ſide with leſſer *pinnulæ*, at the extremities of which appear the polypes. See fig. 18. which ſhews one of the ſeparate pinnæ, a little magnified. This ſpecies is of a fine red or light ſcarlet colour, and when alive exhibits a ſtong phoſphoreſcent light, ſo as to render diſtinctly viſible objects that are near it. It is pretty common on the coaſts of Britain, and is ſometimes taken in the fiſhermen's nets, or adhering to the baits.

For figures of two other Linnæan zoophytes, the TUBULARIA *magnifica*, and HYDRA *viridis*, ſee Plate CCLIII.

ZOOPHYTES. Plate DLXXIX.

Fig. 1.

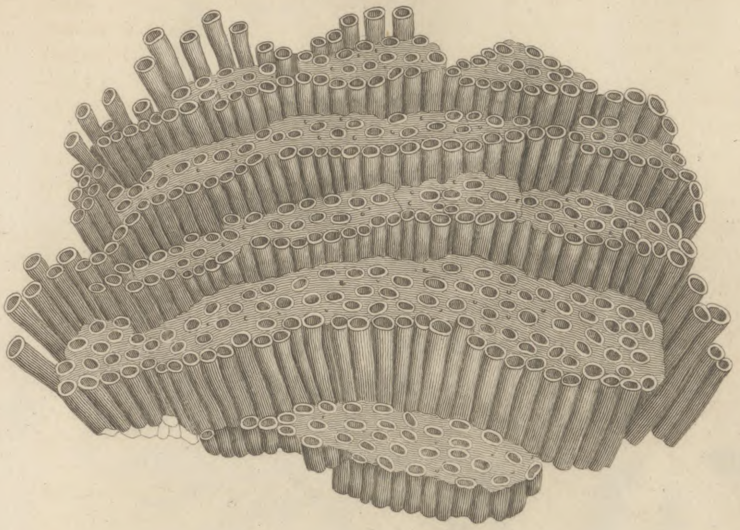


Fig. 2.

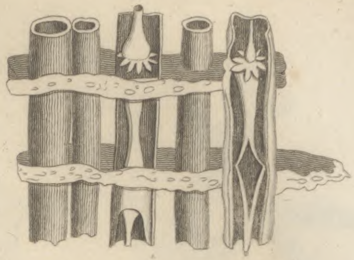


Fig. 3.

Fig. 4.

Fig. 5.

Fig. 6.

W. Archibald sc.

ZOOPHYTES.

Plate DLXXX.

Fig. 8.

Fig. 7.

Fig. 9.

Fig. 11.

Fig. 10.

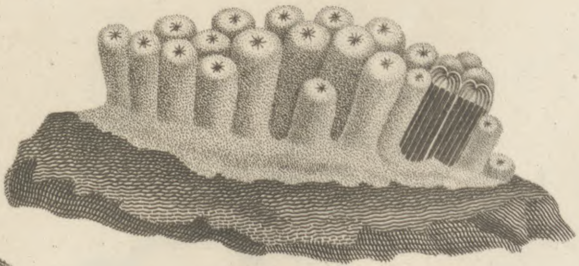


Fig. 12.

W. Archibald sc.

Fig. 13.

Fig. 14.

Fig. 16.

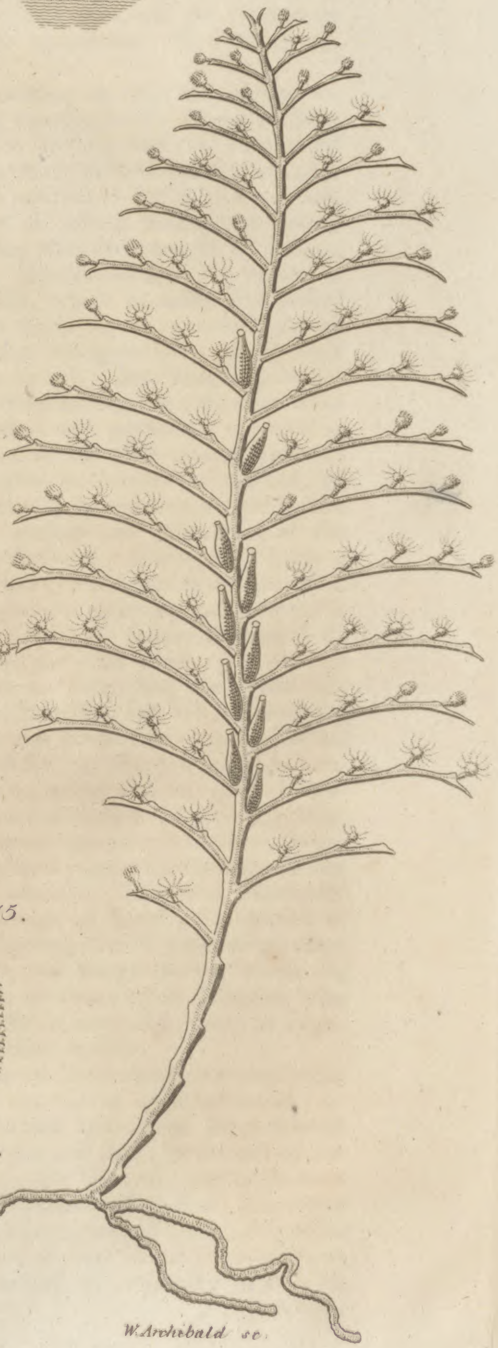


Fig. 17.

Fig. 18.

Fig. 15.

W. Archibald sc.

CCLIII. Several of Cuvier's zoophytes are repreſented in Plates XXXIV. CCLI. and CCLII. and ſome of the *Infuſoria* in Plates XXXV. and XXXVI.

ZOOTOMY, the art of diſſecting animals or living creatures, being the ſame with anatomy. See ANATOMY.

ZORILLE, a ſpecies of weeſel which inhabits Peru, and other parts of South America; and is ſaid to be remarkable for its fetid odour.

ZOROASTER, or ZERDUSHT, a celebrated ancient philoſopher, ſaid to have been the reformer or the founder of the religion of the magi. It is wholly uncertain to how many eminent men the name of Zoroaſter belonged. Some have maintained that there was but one Zoroaſter, and that he was a Perſian; others have ſaid that there were ſix eminent founders of philoſophy of this name. Ham the ſon of Noah, Moſes, Oſiris, Mithras, and others, both gods and men, have by different writers been aſſerted to have been the ſame with Zoroaſter. Many different opinions have alſo been advanced concerning the time in which he flouriſhed. Ariſtotle and Pliny fix his date at ſo remote a period as 6000 years before the death of Plato. According to Laertius, he flouriſhed 600 years before the Trojan war; according to Suidas, 500. If, in the midſt of ſo much uncertainty, any thing can be advanced with the appearance of probability, it ſeems to be this; that there was a Zoroaſter, a Perſo-Median, who flouriſhed about the time of Darius Hyſtaſpes; and that beſides him there was another Zoroaſter, who lived in a much more remote period among the Babylonians, and taught them aſtronomy. The Greek and Arabian writers are agreed concerning the exiſtence of the Perſian Zoroaſter; and the ancients unanimouſly aſcribe to a philoſopher, whom they call *Zoroaſter*, the origin of the Chaldean aſtronomy, which is certainly of much earlier date than the time of Hyſtaſpes: it ſeems, therefore, neceſſary to ſuppoſe a Chaldean Zoroaſter diſtinct from the Perſian. Concerning this Zoroaſter, however, nothing more is known, than that he flouriſhed towards the beginning of the Babyloniſh empire, and was the father of the Chaldean aſtrology and magic. All the writings that have been aſcribed to Zoroaſter are unqueſtionably ſpurious.

ZOSTERA, a genus of plants of the claſs gynandria, and in the natural ſyſtem arranged under the ſecond order, *Piperitæ*. See BOTANY *Index*.

ZOSIMUS, an ancient hiſtorian who lived at the end of the fourth and beginning of the fifth century. There are ſix books of his hiſtory extant; in the firſt of which he runs over the Roman affairs in a very ſuccinct manner from Auguſtus to Diocleſian; the other five are written more diffuſely. Zoſimus was a zealous Pagan; whence we find him frequently inveighing with great bitterneſs againſt the Chriſtian princes, particularly againſt Conſtantine the Great, and the elder Theodoſius. His hiſtory has been publiſhed with the Latin verſion of Leunclavius at Frankfort, 1590, with the other minor hiſtorians of Rome, in folio; and at Oxford in 8vo, 1679.

ZUG, a canton of Switzerland, bounded on the eaſt and north by that of Zurich, on the ſouth by Schweitz and Lucern, and on the weſt by the canton of Lucern and the Freye-Amt or Free Provinces. It is not above 12 miles either way; but very populous and fruitful, yielding wine, wheat, cheſnuts, and other fruits, in its vales, and excellent paſture on its mountains. The inhabitants of this canton are ſtaunch Roman Catholics. It lies in the dioceſe of Conſtance, and its government is democratical. There are two lakes in it abounding in fiſh, particularly large carps, pikes, and a ſpecies of trouts called *rotels*; as well as ſeveral woods full of game. Zug, which gives name to it, and is its capital, ſtands on the eaſt ſide of a lake of the ſame name, about ſeven miles long, and is a ſtrong neat town, containing a priory and two convents.

ZUILA, a town in the territory of Fezzan, in Africa, which ſtands on a ſpace of about a mile in circuit, but was formerly of much greater extent. The environs are level, well ſupplied with water, and fertile, planted with groves of date trees, and the inhabitants pay much attention to agriculture. N. Lat. 27. 29. E. Long. 16. 39.

ZUINGLIUS, ULRICUS, an able and zealous reformer, who laid the foundation of a ſeparation from Rome in Switzerland, at the ſame time that Luther did the like in Saxony, was born at Wildehauſen in 1487. While he officiated as preacher at Zurich, a Franciſcan ſent by Leo X. came to publiſh indulgences there; againſt which Zuinglius, after the example of Luther, declaimed powerfully. In the courſe of this oppoſition he ſtarted a new doctrine, which he called *Evangelical Truth*; and from the beginning of 1519 to 1523, he preached not only againſt indulgences, but againſt other articles of the Romiſh church. But though Zuinglius made no leſs progreſs than Luther, he conducted himſelf with more moderation and prudence; and wiſhing to have the concurrence of the civil powers, procured two aſſemblies to be called at Zurich: by the firſt, he was authoriſed to proceed as he had begun; and by the ſecond, the outward worſhip and ceremonies of the church of Rome were aboliſhed. During theſe tranſactions, Zuinglius publiſhed ſeveral books in defence of his doctrines; but treating of the euchariſt, and preſcribing a form of celebrating the Lord's Supper different from Luther, he was involved in violent diſputes with the reſt of his reforming brethren. Reſpecting the divine DECREES, the opinion of Zuinglius and his followers differed very little from that of the PELAGIANS: and inſtead of declaring with Calvin, that the church is a ſeparate independent body, veſted with the right of legiſlation for itſelf, Zuinglius aſcribed to the civil magiſtrate an abſolute and unbounded power in religious matters, allowing at the ſame time a certain ſubordination among the miniſters of the church. This was abundantly agreeable to the magiſtrates of Zurich; but the reſt of the Swiſs cantons diſallowing of their proceedings, other aſſemblies were called, and things tending to tumult, both ſides had recourſe to arms; when Zuinglius, who began as a preacher, died in arms as a ſoldier, in 1531. His works are in four volumes folio.

ZURICH, a canton of Switzerland, bounded to the north by Swabia and the canton of Schaffhauſen; to the ſouth by the town and territory of Rapperſchweil and the cantons of Switz and Zug; to the eaſt by the Thurgau, Toggenburg, and Utznach; and to the weſt by the free bailiages and county of Baden. It is about 60 miles from north to ſouth, and 48 from eaſt to weſt. With reſpect to its face, air, and ſoil, it is ſaid to be an epitome of all Switzerland, as containing in it hills, valleys,

valleys, plains, corn-lands, vineyards, lakes, and rivers. Their wines have a tartneſs at firſt, but the longer they are kept the more agreeable they are. The other products are excellent fruits, corn, paſture, fine clay, chalk, ſeveral coloured earths, pit-coal, turf, and ſulphur. There are alſo ſome mineral ſprings in the canton, and ſome lakes; Zurich is the moſt conſiderable, it is 24 miles long, and two broad. The reformation was introduced here by Zuinglius in the year 1517. This canton is the firſt in rank, and inferior only to that of Bern in extent, power, and wealth; in conſequence of which, its repreſentatives preſide in the general diets, when held in any place belonging in common to the cantons; and the affairs relating to the whole confederacy are tranſacted in its offices. Its quota, for the defence of the ſeveral members of the confederacy, is 1400 men. Of one of the two armies raiſed on theſe occaſions, it nominates one of the commanders in chief, as Lucern does the other. Its revenue is ſaid to be about 150,000 crowns a-year; of which, one year with another, two thirds are expended in the charges of government, and the reſt laid up in the treaſury. It can bring 50,000 fighting men into the field at a very ſhort warning.

Zurich, the capital of a canton of the ſame name in Switzerland, ſtands in a pleaſant country, near where the river Aa iſſues from the lake that takes its name from the town, 23 miles from Schaffhauſen, and 114 from Geneva. After having been ruined by Attila the Hun, it is ſaid to have been reſtored by Thuricus, ſon of Theodoric king of the Goths, from whom it took the name of *Thuricum*, corrupted afterwards into that of *Zurich*. It is fortified in the modern way, and has wide ditches, faced with free-ſtone. There are five arſenals in it, well ſtored with arms and artillery; an academy or college, having 15 profeſſors; a muſeum, or chamber of rarities; a ſtately town-houſe, the pillars in the front of which are of black marble, ſtreaked with white; and a town library. The ſovereignty and adminiſtration of all affairs are lodged in the greater and leſſer council, out of which are choſen the city-officers, as the councils are out of the 13 companies of burghers. There are ſeveral other councils or colleges, each of which has its particular department. Here are a great variety of ſilk, woollen, linen, cotton, and other manufactures; this being the place of the greateſt trade in all Switzerland. The town is well ſupplied with proviſions by and from its lake. The ſtreets are neat, and houſes well built, but not magnificent. In the town-library are ſeveral letters to Bullinger from Lady Jane Gray, daughter to the duke of Suffolk. In one of the arſenals is the figure of William Tell, dreſſed and armed in the ancient Swiſs manner, with the croſs-bow whence he ſhot the arrow that ſtruck the apple off his child's head.

2

Both men and women are ſo fond of muſic, that there are few of them that cannot play on ſome inſtrument. If a burgher goes out of town, or a peaſant enters it, without a ſword, they are liable to be fined. No perſons, whatever their rank or office may be, are exempted from the ſumptuary laws. The burgomaſters, who are the ſame as the advoyers at Bern, have the title of excellence. The hoſpitals here are neat and well endowed. The environs are pleaſant and fruitful; for which it is not a little indebted to the lake. That part of it which is next Zurich is called the *Lower Lake*, and the other end the *Upper*. The cathedral, or great church here, is collegiate. The preſent city is ſaid to owe its origin to a nunnery, founded by the emperor Lewis I. near where the ancient Tigurum ſtood. E. Long. 8. 30. N. Lat. 47. 20.

ZUTPHEN, a ſtrong and conſiderable town of the United Provinces in Guelderland, and capital of a county of the ſame name. It has a magnificent church, and is ſurrounded with walls. It was taken by the French in 1672, who in 1674 delivered it up to the States-General. It is ſeated at the confluence of the rivers Berkel and Yeſſel, nine miles ſouth-eaſt of Deventer, and 55 eaſt by ſouth of Amſterdam. E. Long. 6. 0. N. Lat. 52. 10.

ZUYDER-ZEE, a great gulf or bay of the German ocean, which extends from ſouth to north in the United Provinces, between Frieſland, Over-Yeſſel, Guelderland, and Holland. It is ſo called from its ſituation towards the ſouth. It is ſaid that the Zuyder-zee was formerly a lake, and that the land is ſwallowed up which united North-Holland with Frieſland.

ZYGOMA, a bone of the head, or rather an union or aſſemblage of two proceſſes or eminences of bones. See *Bones of the Head*, under ANATOMY.

ZYGOMATICUS, a muſcle of the head, ariſing from the *Os* ZYGOMA, whence its name, and terminating at the angle of the lips.

ZYGOPHYLLUM, BEAN-CAPER, a genus of plants of the claſs of decandria, and in the natural ſyſtem arranged under the 14th order, *Gruinales*. See BOTANY *Index*.

ZYMOSIMETER (formed from *ζυμωσις*, *fermentation*, and *μετρον*, *meaſure*), an inſtrument propoſed by Swammerdam, in his book *De Reſpiratione*, with which to meaſure the degree of fermentation occaſioned by the mixture of different matters, and the degree of heat which thoſe matters acquire in fermenting; the ſame inſtrument is employed to aſcertain the heat of temperament of the blood of animals.

FINIS.

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Edinburgh.

DIRECTIONS FOR PLACING THE PLATES OF VOLUME XX.

PART I.

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DXXXIII. & DXXXIV.	-	400

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DLXXVIII.	- - -	792
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ERRATA.

N. B *b* added to the number of the line ſignifies " from the bottom of the page."

Vol.	*page.*	*col.*	*line.*	
I.	7	1	59	*for* retrenchment, *read* intrenchment.
	10	1	9	*for* meal, *read* meat.
	42	1	8	*for* gift, *read* gifts.
				(For the errata in ALGEBRA, ſee the end of this volume.)
	790	2	15	*for* מו , *read* אמנ.
II.				In Plate XXI. fig. 6. letter E omitted.
				fig. 4. F omitted.
				fig. 3. FF omitted.
				In Plate XXII. fig. 15. G omitted.
				XXIX. fig. 1. *d d* and *e* omitted.
				fig. 5. *h h* omitted.
	320 margin,			*for* N° 1. *read* fig. 1.
				In Plate XXXIV. fig. 1. *a* omitted.
	374 margin,			*for* Plate XXXII. *read* XXXVI.
III.	44 margin,			*for* fig. 20. *read* fig. 18.
	48	2	20	*for* emerſion, *read* immerſion.
	290			AYRSHIRE; for correcting error in the boundaries of, ſee KYLE.
	613			BILLS; for the duty on, ſee EXCHANGE, *Bills of*, vol. viii. 369.
	639			BLACK, *Life of*; ſee error with regard to M. de Luc's plagiariſm, corrected in note at p. 706, of vol. xiii.
IV.	44	3	49	*for* micrometical, *read* micrometrical.
	477			in ſome copies, *for* 1783, *read* 1683.
	680	2	6	in ſome copies, *for* ſeceſs, *read* ſucceſs; and *for* 1793, *read* 1794.
V.	116	1 *b.*		*inſert* is.
				for lochs, *read* locks.
	340			in ſome copies, *for* Delphinius, *read* Delphinus.
	356			*for* extrrordinary, *read* extraordinary.
VI.	569	2		*for* 1002, *read* 912.
VII.	155			DEMERARY omitted. See SURINAM.
	230	1	12	*for* gules, *read* gulls.
VIII.	9	2	30 & 33	*for* $\frac{y\dot{y}}{x}$ *read* $\frac{y\dot{y}}{\dot{x}}$
	291	1		ſide note, *for* Trav. vol. iii. *read* vol. ii.
	304	2	29	*for* larva, *read* larvæ.

ERRATA.

Vol.	*page.*	*col.*	*line.*	
IX.	332	1	19	*for* iron wire, *read* zinc wire.
	—	—	31	*for* iron wire, *read* zinc wire.
	—	2	40	*for* fig. 2. read fig. 3.
	—	—	42	*for* bodies, *read* body.
	—	—	44	*for* fig. 3. *read* fig. 4.
	554	1	56	*for* Barrand, *read* Barrow.
	570	—	42	*for* gallium, *read* galium.
	571	—	36	*for* gloſſoptra, *read* gloſſopetra.
	629	—	13 *b.*	*for* was, *read* is.
	630	—	16 *b.*	*for* of, *read* on.
	631	—	6 *b.*	*for* angle, *read* angles.
	—	2	2	*for* Legandre, *read* Legendre.
	638	1	8 *b.*	*for* AH, *read* CH.
	640	1	28	*for* ABD+CBD, *read* ABC+ADC.
	642	—	8	*for* then as *m* A, *read* then *m* A.
	646	2	18	*for* AH, *read* BH.
	652	—	13 *b.*	*for* $\frac{1}{2}$ B, *read* $\frac{1}{2}$ BC.
	655	1	21	*for* DEE, *read* DEF.
	656	—		between lines 21 and 22, *inſert* 2048 3·1415877 3.1415951.
	—	2	8	*for* or half, *read* half.
	658	1	3	*for* EEG=H, *read* EF=GH.
	660	2	23	*for* here, *read* there.
	662	1	6	*for* if ſpace P and Q, *read* if P and Q.
	663	2	12 *b.*	*for* ADE, *read* ABE.
	780	1		*GOODWIN Sands* omitted; for deſcription of, ſee KENT.
X.	427	2	29	*for* Hebbelol, *read* Herbelot.
XI.	81	2	2	*for* Black, *read* Bloch.
	88	2	20	*for* Macrocerus, *read* Macrourus.
	92	1	11	ſide notes, *for* amata, *read* aurata.
XII.	66	1	15	*for* ligitima, *read* legitima.
	67	1	18, 19 *b.*	*for* Vlack, *read* Vlacq.
	70	1	laſt line,	*for λογῶν ἀριθοι, read λογον ἀριθμοὶ.*
	71	2	10 *b.*	*for* r N *read* r^N
	72	1	10 *b.*	*for* z^3, *read* z^2.
	74	2	25, 27	*for* Napierian, *read* Napierean.
	79	1	1	*for* $n \times 1$, *read* $n+1$.
	80	1		the reference to the plate and figure is wanting.
XIV.	75, 76			under Explanation of Plates, *for* Plates CCC, CCCI, CCCII, CCCIII, and CCCIV. *read* CCCXLVI, CCCXLVII, CCCXLVIII. CCCXLIX, and CCCL.
				Errata in MIDWIFERY, ſee the end of the article.
XVI.	520	1	5	*for* chryſolites, *read* chryſalids.
XVII.	242	2		ſide note, *for* Plate CCCCXXXVIII. *read* CCCCXXXIX.
	265	2	24, 26	*for* M′EM′, *read* M′EM″.
				Under PRUSSIA, ſide note, *for* Plate CCCCXLIV. *read* CCCCXXXIV.
	226	1	20 *b.*	*for* D, *read* K.
	428	2	1	*for u*, *read n.*
XVIII.	89	2	12 *b.*	*for* laſt, *read* 17th in note on RUSSIA. See end of vol. xviii.
XIX.	737			STOVE. In the deſcription of the ſtove, fig. 5. it is not mentioned as a patent ſtove, the patent not having been announced till a few days after the deſcription was printed.
	599	—	10 note,	*for* 30, *read* 100 beads.
XX.	25	2	43	*for* broken, *read* broke.
	33	—	48	*for* ployment, *read* employment
	45	—	27	*for* farunculus, *read* furunculus.
	47	—	9	*for* labiæ, *read* labia.
	56	—	8	*for* bladner, *read* bladder.

Plate

HISTORICAL CHART.

Representing at one View the rise and progreſs of the Principal States & Empires of the known World.

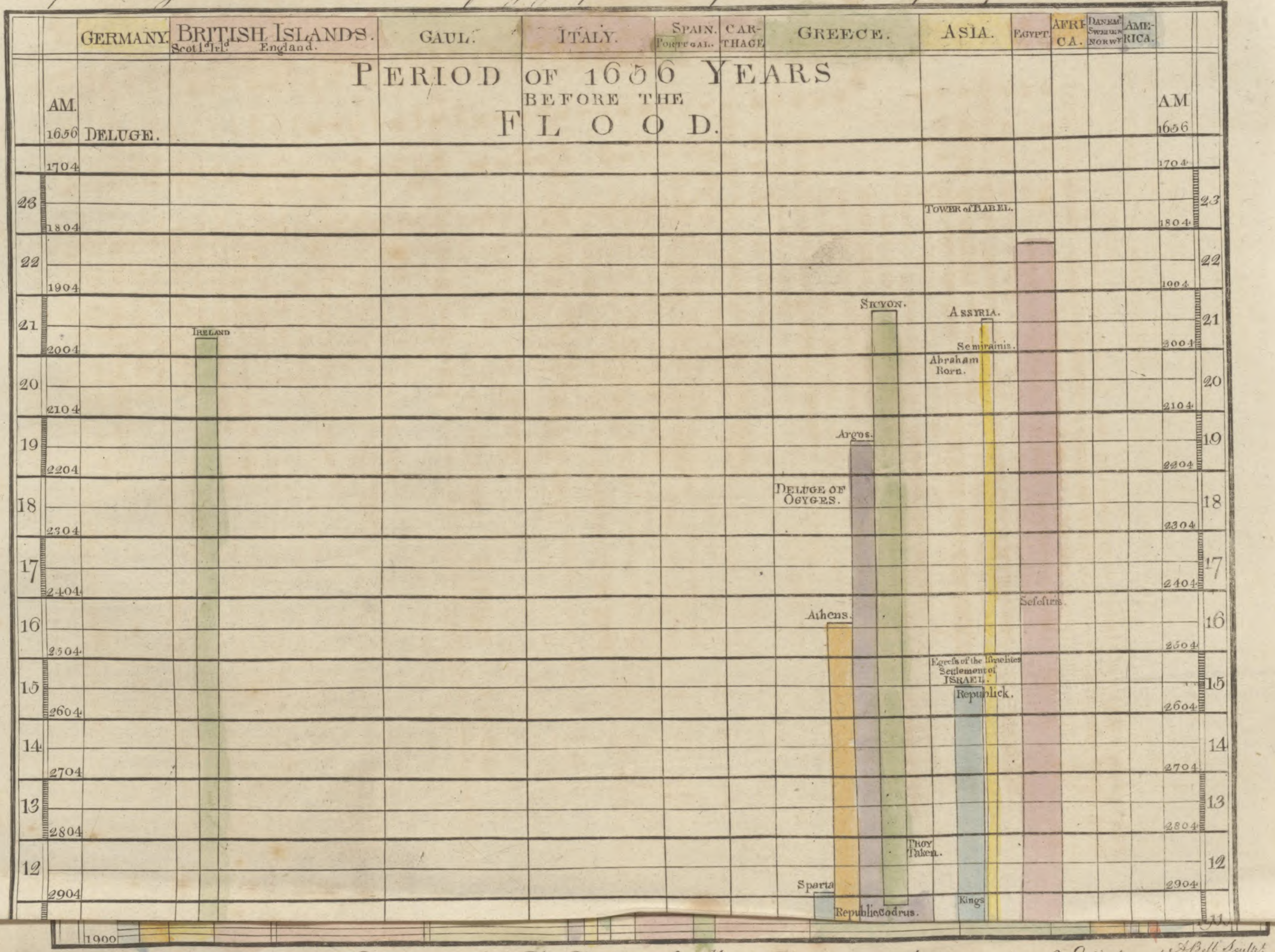

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Plate

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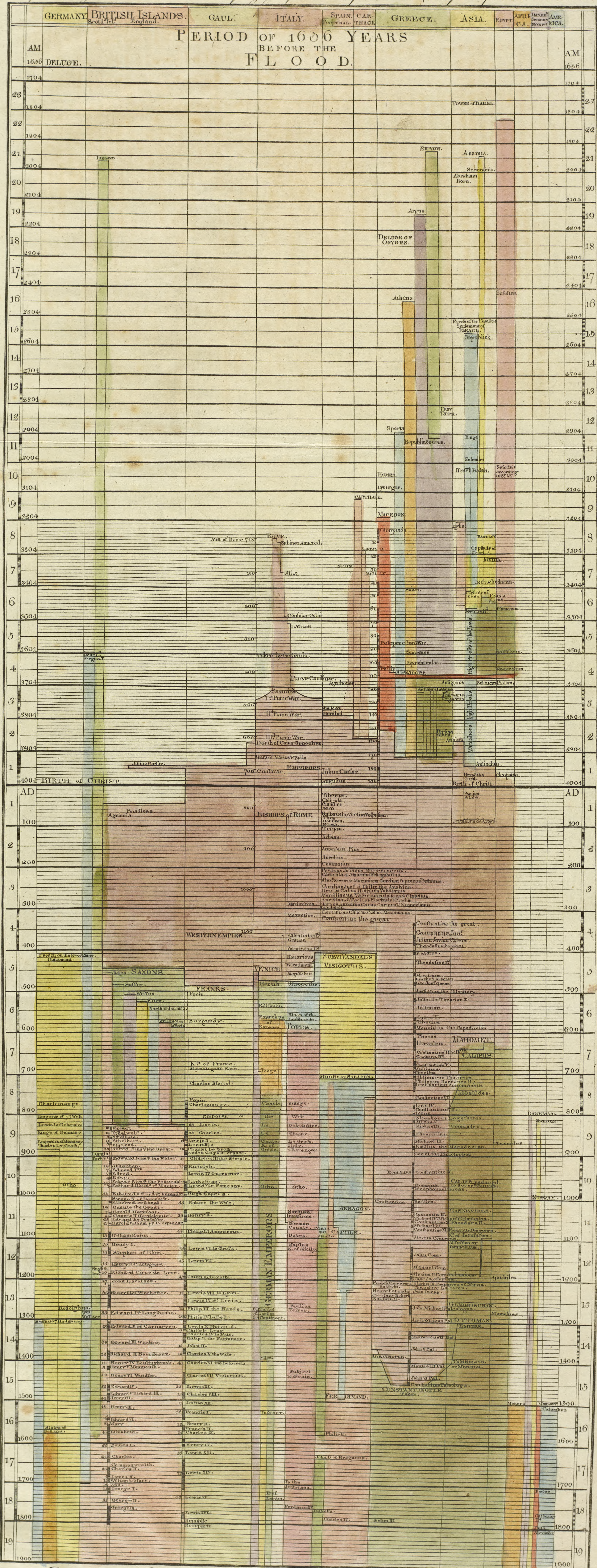

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E. Mitchell ſculp^t

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TO

THE KING.

In requesting permission to inscribe to your Majesty the present Edition of the Encyclopædia Britannica, the Proprietor hopes, that this humble testimony of his loyalty and duty will be graciously received. In this expectation he is the more encouraged, when he considers the zeal which your Majesty has uniformly shown for the improvement of Arts and Sciences, and the known benevolence of your Majesty's disposition, which has long made you revered as the Father of your People, and which has always secured a favourable reception to the requests of your subjects.

That, by the wisdom of your Councils, and the vigour of your Fleets and Armies, your Majesty may be enabled soon to restore peace to Europe; that you may again have leisure to

direct

direct your undivided attention to the improvement of Arts, and the advancement of Knowledge; that you may long reign over a free, a happy, and a loyal people; and that the Sceptre of the British Empire may be swayed by your Majesty's descendants to the latest posterity, is the earnest prayer of

Your MAJESTY's

Most dutiful Subject,

And devoted Servant,

ANDREW BELL.

Lauristoun, Edinburgh,
1809.

PREFACE.

In the present improved state of science, of literature, and of all those arts which are connected with the progress and improvement of society, it is surely unnecessary to dwell on the importance of a work, the chief object of which is to exhibit a view of those great and interesting subjects. If science, while its beneficial influence is felt in all the common pursuits of life, affords scope at the same time to the greatest exertions of human genius; if literature is both the delight and ornament of those by whom it is cultivated; and if history, by bringing under our review the great course of human affairs, enables us to draw lessons for our future conduct from the unerring experience of the past, there can be no question as to the importance of a work comprising so many objects of deep and general interest to mankind. It deserves also to be remarked, that many of those great discoveries which have effected a revolution in science, and which have gradually introduced the most striking changes into the affairs of the world, have been the fruit not of accident, but of the most painful and abstruse inquiries; and that the great powers of invention and genius necessary to explore those intricate paths, do not by any means imply the same capacity of plain and familiar illustration;—those who possess those rare endowments being, on the contrary, rather averse to waste their precious talents on what appears to them to be the natural employment of more ordinary minds. It is hardly necessary, however, to point out to the reader how greatly the cause of philosophy must be promoted, when its important truths, in place of being confined to the speculative few, are expounded in popular works, and in this manner diffused among all classes of the community, so as to be the common topics of men's discourse,—thus adding to their innocent and laudable recreations, and setting to work at the same time, in the cause of literature and science, an additional stock of talent and exertion. Such being the obvious advantages arising from a well-digested account of Science, of Literature, and of General History, we shall not enlarge farther on the utility of the present work. As in such an undertaking, however, the execution is of as much importance as the plan, we shall endeavour, as shortly as possible, to satisfy the reader that, in that particular, no pains nor expence

pence have been spared to render the present edition as perfect as possible, and to give it a fair claim to that share of popularity and reputation, so amply enjoyed by the ENCYCLOPÆDIA BRITANNICA from the first moment of its publication.

In so complicated a work, it is obviously of infinite importance to preserve a clear and accurate arrangement, so as to give unity and consistency to its various parts; for it is evident that, without constant attention to method and order, such a work may be rendered in a great measure useless: and though it may still be an immense and valuable register of knowledge, the reader may search through its pages without any clue to guide him to the object of his inquiries. It is in this particular that the first rude essays towards a compilation of this kind are so extremely defective. The alphabet, in place of being employed in the humble function of an index to the matter contained in the work, was made supreme arbiter of the whole arrangement; and the different sciences, instead of following their natural order, were cut down into detached parts, out of which no great whole could possibly be formed. In this view the alphabet, far from conducing to clearness, became an instrument of disorder; and its only use appeared to be, to save the writers to whom we allude from the trouble of a more accurate or philosophical arrangement. Those obvious defects in all the most popular dictionaries of arts and sciences were observed by Mr Chambers, the compiler of a very valuable work of this kind himself; and, in speaking of the labours of his predecessors, he particularly censures the inattention to method, so visible in every part of their performances. "Former lexicographers (he observes) scarce attempted any thing like structure in their works; they seem not to have been aware that a dictionary is in some measure capable of the advantages of a continued discourse; and hence it is, that we see nothing like a whole in what they have done." For the purpose of remedying this defect in his own work, he informs his readers, that "his view was to consider the several matters, not only in themselves, but relatively, or as they respect each other; both to treat them as so many wholes, and as so many parts of some greater whole; and to point out their connection with each other, and with that whole, by reference: so that by a course of references from generals to particulars, from premises to conclusions, from cause to effect, and *vice versa*, a communication might be opened between the several parts of the work, and the detached articles be in some measure replaced in the natural order of science, out of which the alphabetical order had removed them." With a view of exhibiting a connected view of the various articles scattered through his dictionary, Mr Chambers has accordingly prefixed to it an analysis, from which may be seen, at one view, the mutual connection and dependence of its various parts.

But although the arrangement of the Cyclopædia of Mr Chambers is much preferable to that of any former work of the kind, it is still liable to many of those objections for which he censures his predecessors. Even if his original plan had been carried into effect with complete success, and all the articles in different parts of his work had been so managed, as, when reunited, to have made so many complete systems, the number of references was still so great that no reader could possibly have submitted to the trouble of combining them (A).

Of

(A) To be convinced of the truth of this assertion, one needs but to cast his eye over the author's table of arrangement. It is as follows.

KNOWLEDGE is either

- *Natural* and *Scientifical;* which is either —
  - *Sensible;* consisting in the perception of phenomena or external objects—called PHYSIOLOGY or NATURAL HISTORY; and which, according to the different kinds of such objects, divides into —
    - METEOROLOGY.
    - HYDROLOGY.
    - MINERALOGY.
    - PHYTOLOGY.
    - ZOOLOGY.
  - OR,
  - *Rational;* consisting in the perception of the intrinsic characters or habitudes of sensible objects — either their — — —
    - *Powers,* and *Properties*—called PHYSICS, and NATURAL PHILOSOPHY.
    - *Abstracts*—called METAPHYSICS, which subdivides into
      - ONTOLOGY.
      - PNEUMATOLOGY.
    - *Quantities*—called PURE MATHEMATICS—which divides, according to the subject of the quantity, into —
      - ARITHMETIC—whence
        - ANALYTICS.
        - ALGEBRA.
      - GEOMETRY—whence
      - STATICS —
        - TRIGONOMETRY.
        - CONICS.
        - SPHERICS.
    - *Relations* to our happiness—called RELIGION, or the doctrine of OFFICES, which subdivides into
      - ETHICS, or NATURAL RELIGION—whence
        - POLITICS.
        - LAW.
      - THEOLOGY, or REVELATION.
- OR,
- *Artificial* and *Technical,* (consisting in the application of natural notices to farther purposes), which is either —
  - *Internal;* employed in discovering their agreement and disagreement; or their relations in respect of truth—called LOGIC.
  - OR,
  - *External;* which is either
    - *Real,* employed in discovering and applying the
      - *Latent powers* and *properties* of bodies—called CHEMISTRY—whence
        - ALCHEMY.
        - NATURAL MAGIC, &c.
      - *Quantities* of bodies — called MIXED MATHEMATICS; which according to the different subjects, resolves into —
        - OPTICS, CATOPTRICS, DIOPTRICS, —whence
          - PERSPECTIVE.
          - PAINTING.
        - PHONICS—whence MUSIC.
        - HYDROSTATICS, HYDRAULICS.
        - PNEUMATICS.
        - MECHANICS—whence
          - ARCHITECTURE.
          - SCULPTURE.
          - TRADES and MANUFACTURES.
        - PYROTECHNIA—whence
          - The MILITARY *Art.*
          - FORTIFICATION.
        - ASTRONOMY—whence
          - CHRONOLOGY.
          - DIALLING.
        - GEOGRAPHY, HYDROGRAPHY—whence
          - NAVIGATION.
          - COMMERCE.
      - *Structure* and *economy* of organical bodies, called ANATOMY.
      - *Relations* thereof to the preservation and improvement—either of —
        - Animals—called
          - MEDICINE.
          - PHARMACY.
        - Vegetables—called
          - AGRICULTURE.
          - GARDENING.
        - BRUTES—called
          - FARRYING.
          - MANEGE—whence
            - HUNTING.
            - FALCONRY.
            - FISHING, &c.
    - OR,
    - *Symbolical,* employed in framing and applying
      - *Words,* or articulate signs of ideas—called GRAMMAR.
      - *Armories*—called HERALDRY.
      - *Tropes* and *Figures*—called RHETORIC.
      - *Fables*—called POETRY.

Such

Of this inconveniency, inseparable from a mere *dictionary* of arts and sciences, the original compilers of the Encyclopædia Britannica were fully aware; and they resolved, in the conduct of their work, to adopt such a plan as should completely free it from this objection. They were as fully convinced as their predecessors of the utility of a separate explanation of every technical term, and of the necessity also of noticing, in detail, many topics which it would be proper more fully to illustrate in the general account of the respective sciences to which they belonged. They were sensible, however, at the same time, how greatly the progress of useful knowledge is facilitated by systematical arrangement, and how necessary it is for those to think methodically who expect to benefit mankind by their labours. They have accordingly endeavoured, in place of the awkward expedient of a prefatory analysis, adopted by Mr Chambers, to exhibit a clear and satisfactory account of the several arts and sciences under their proper denominations, and to explain at the same time the subordinate articles under their technical terms. These articles may be divided into three kinds. The first consists of such as, not depending very closely on particular systems, admit of a complete explanation under their proper names; the second of such as require to be considered in the general account of the sciences with which they are connected, and also under their own denominations; and the third, of such as belong to a great whole, from which they cannot be separated, so as to be explained in detail. Articles of the first kind admit, of course, of no references; those of the second sort, being only partially explained under their own denominations, the reader is referred for more complete information to the article where the subject is more fully illustrated; and in articles of the third description, no attempt is made to explain them, except in connection with the subjects to which they severally belong, and to which the reader is therefore always referred.

Such

Such is that great and general analysis of knowledge, which has by some of our correspondents been recommended to us in terms of the highest praise, and to which elegance and accuracy cannot perhaps be refused. Its utility, however, as prefixed to a dictionary of arts and sciences, is not very apparent. From each word, which in this table is printed in capitals, many branches are made to spring, which in the dictionary are all treated as separate articles. Thus, from METEOROLOGY we are referred, in a subordinate analysis, to AIR and the ATMOSPHERE; including, 1st, The history of its contents, ÆTHER, FIRE, VAPOUR, EXHALATION, &c. 2d, METEORS formed therein; as CLOUD, RAIN, SHOWER, DROP, SNOW, HAIL, DEW, DAMP, &c. RAINBOW, PARHELION, HALO, THUNDER, WATERSPOUT, &c. WINDS, MONSOON, HURRICANE, and the like. As every word printed in capitals, as well in this subordinate division as in the general table, is the title of an article treated separately in the Cyclopædia, we must turn backwards and forwards through more than 24 references before we come at the detached topics, which we are directed to unite into a system of METEOROLOGY. The number of articles which must be united in the same manner to constitute the Compiler's system of METAPHYSICS is upwards of 48; and those which are referred to THEOLOGY above 300!

Such is the arrangement adopted in every edition of the ENCYCLOPÆDIA BRITANNICA; and there appears to be no other, by which the great object of such a work would be so easily and so completely attained. The necessary effect of such a plan must be, to give to readers of every description the most easy access to the objects of their various pursuits; for, whilst the philosopher or artist may procure whatever information he is in search of, by turning to the general name of the science to which his attention is directed, those who are desirous of information on particular topics will find them explained with sufficient accuracy under their respective denominations. Considered in this point of view, the ENCYCLOPÆDIA BRITANNICA may vie in the accuracy of its arrangement with the *Encyclopédie Methodique;* for though that voluminous work undoubtedly has an imposing appearance, yet we, who, in the course of our labours, have had to consult it frequently, have never found our object the more readily, for having been obliged to travel in quest of it through different alphabets.

A dictionary, in which the several arts and sciences are digested into distinct treatises or systems, whilst the various detached parts of knowledge are explained in the order of the alphabet, seems indeed to have received the best form of which such a work is susceptible; and may certainly be made to answer one end, which more philosophical arrangements never can accomplish. Under the various letters of the alphabet, it is obvious that the whole circle of the sciences may be completely exhausted; and that every discovery, ancient or recent, may be referred to the particular system which it tends to confute or to confirm, without having recourse to the awkward expedient of employing several alphabets, or the still more inconvenient arrangement by which the systems themselves are broken into fragments.

The truth of these observations is confirmed beyond the possibility of doubt, by the favourable reception which every edition of the ENCYCLOPÆDIA BRITANNICA has hitherto met with; by the still greater encouragement which has been given to the present; and by the circumstance of its plan having been invariably adopted by the editors of all similar works. On this subject, the proprietors of the present edition express themselves with the greater ease and confidence, as they cannot be accused of flattering their own vanity, or of being the publishers of their own praise. The merit of the arrangement, as well as of various other improvements suggested in the course of the work, belongs not so much to them, as to the compilers of the first edition.

To a work which proposes as its main object to exhibit a view of the Arts and Sciences, the private history of those eminent persons by whose ingenuity the progress of science has been promoted, seems to be a proper accompaniment. Those who formed the plan of the ENCYCLOPÆDIA BRITANNICA resolved accordingly to improve it, by the addition of one department, not to be found in any former compilation of the kind, with the exception of the French *Encyclopédie.*

Of all the various sorts of narrative-writing, it is acknowledged that none is more worthy of cultivation than Biography, since none can be more delightful or more useful; none can more certainly enchain the heart by irresistible interest, or more widely diffuse instruction to every diversity of condition. Its tendency to illustrate particular passages in general history, and to diffuse new light through such arts and sciences as were cultivated by the persons whose lives are related, are facts too obvious to require proof. It exhibits likewise the human character in every possible form and situation. It not only attends the hero through all the bustle of public life, but pursues him to his most sequestered retirements. It shows how distinguished characters have been involved in misfortunes and difficulties; by what means they were extricated; or with what degree of fortitude and dignity they discharged the various functions, or sustained the vicissitudes, sometimes prosperous and sometimes adverse, of a checquered and a fluctuating life. In such narratives, men of all ranks must feel themselves interested; for the high and the low, as they have the same faculties and the same senses, have no less similitude in their pains and pleasures; and, therefore, in the page of honest biography, those whom fortune or nature has placed at the greatest distance, may mutually afford instruction to each other. For these reasons it is, that every man of learning and taste has esteemed the biographical labours of Plutarch among the most valuable and interesting remains of antiquity.

The lives and characters, therefore, of such persons as have excelled in the arts either of war or of peace, of such as have distinguished themselves either on the theatre of action, or in the recess of contemplation, will be found in the ENCYCLOPÆDIA BRITANNICA alphabetically disposed under their proper names. In former editions of this work, many names are omitted for which the reader will naturally look; some because the work had advanced beyond the initial letters of their names before the editor received intelligence of their deaths; others through inadvertency, and from various mistakes, against which it is difficult to provide in so extensive an undertaking,

taking; and several from the confusion occasioned by the death of the first editor in the midst of his labours. In the present edition, all these defects have been carefully rectified; and the proprietor may safely venture to assert, that it contains a more perfect biographical register than any which has hitherto been offered to the public. Some, indeed, may be disposed to remark, that this department of their work is executed with too great minuteness, and that the names of many persons are dragged from obscurity, who are not proper objects of public regard. To this we shall only reply, with the greatest biographer of modern times, that, in our apprehension, there has rarely passed a life of which a faithful narrative would not be useful; and that, in the lives of the most obscure persons of whom we have given any account, something will be found either connected with recent discoveries and public affairs, or capable of affording a useful lesson to those who may be placed in similar circumstances.

Between eminent achievements and the scenes where they were performed, there is a natural and necessary connexion. The character of the warrior is connected with the fields of his battles; that of the legislator, with the countries which he civilized; and that of the traveller and navigator, with the regions which they explored. Even when we read of the persons by whom, and the occasions on which, any particular branch of knowledge has been improved, we naturally wish to know something of the places where such improvements were made. This curiosity, so natural and so laudable, has been frequently felt by ourselves during the compilation of this work; and to gratify it in others, we have subjoined to the name of every considerable place an account of its situation, its climate, its soil, its peculiarities, its inhabitants, with the manners, customs, and arts; its revolutions, laws, and government, with whatever else appeared necessary for the reader's information, and at the same time admissible into a work of such variety and extent. It is indeed probable, that by many of our readers we shall be thought to have done too much rather than too little in this department; and to have filled our pages with accounts of towns and villages not of sufficient importance to demand general attention. But were it known how many of such places we have excluded from our work, though recommended to us by some of our most obliging correspondents, those who reflect upon the different tastes of mankind, and consider that we wrote for the public at large, would forgive us for having occasionally employed a few sentences in the description of others, which, whatever be their real importance, could not have been omitted without disappointing a very numerous class of readers.

The knowledge of history is so important, not only to the statesman and the legislator, to whom indeed it is absolutely necessary, but likewise to every man who moves in a sphere above that of the lowest vulgar, that a work professing to be a general repository of arts, sciences, and literature, would be exceedingly defective, if it did not contain some information of the transactions of those who have been in possession of the world before us; of the various revolutions of states and empires; and of all the other means which have contributed to bring every thing into the state in which we behold it. Fully aware of this, the compilers of the ENCYCLOPÆDIA BRITANNICA, besides giving a general view of universal history and chronology, have enriched this edition with a short, though they hope luminous, detail of the progress of each particular nation, which from the remotest period to the present time, has acted a conspicuous part on the theatre of the world. The reader therefore will here find a very comprehensive view of Civil History, ancient and modern, in all its branches. Nor have the histories of Nature and Religion been neglected. Of the former, it is not perhaps too much to say, that in all the subdivisions of its three great kingdoms, it will be found more fully, more accurately, and more scientifically, detailed in this work, than in any other dictionary which has yet been published. Of the latter, a brief view is given under the general article History; the unavoidable defects of which are in a great measure supplied by the accounts that will be found, under their proper denominations, of all the considerable sects and opinions which have prevailed in the religious world, from the earliest periods to the present day.

From the original plan of the ENCYCLOPÆDIA BRITANNICA, which hardly seems capable of any improvement, the compilers of the present edition have, except in a very few instances, never deviated; and they can honestly assure their readers, that notwithstanding their adherence to this resolution, they have found ample scope for the exercise both of learning, and diligence in every sort of laborious research. This must necessarily be the case, indeed, in every succeeding edition of such a work as the present, which professes to follow the sciences and the arts through all their changes and refinements, and to present the most accurate view of the state of the world and of all its concerns at the period of each successive publication. This part of their duty, those concerned with the present edition have neither spared labour nor expence faithfully to discharge. Literary journals; the memoirs and transactions of philosophic societies; and all the most valuable dictionaries of arts and sciences, both in our own and in other languages,

guages, have been constantly consulted. The works of the most eminent authors, as well ancient as modern, who have written on any particular art or science, have been collected and compared. Such of them as treat of topics, about which there is no room for controversy, and are at the same time susceptible of abridgement, have been abridged with the greatest care; whilst others, more concise and tenacious of their subjects, have been more closely pursued and more faithfully retained. Upon those branches of science on which the works of other authors furnished nothing fit for the purpose of the Editors, original essays and treatises are inserted, which were composed either by themselves, or by such of their friends as they knew to be intimately acquainted with the subject. On disputed points, whether in the physical or moral sciences, arguments and objections have been displayed in their full force; and of each of the various sects into which the Christian church is divided, the account is generally given by the most eminent clergymen of that sect to whom the Editors could find access.

In executing this part of their task, there were various circumstances connected with the history of the third edition, which greatly added to its difficulties. In so extensive and multifarious a collection, a few mistakes, repetitions, and omissions might naturally be looked for, although the publication were, from the beginning to the end, in the hands of a single individual. When it is known, however, that after the third and last edition of this work was considerably advanced, it was committed to the care of a new editor, ignorant of the contents of what had been already finished and printed, and without any directions from his predecessor to guide him accurately through the remaining part of his task; it will not, perhaps, appear very surprising that inaccuracies, omissions, and repetitions should have occurred. For these defects, the want of an intelligible index to the materials left by the first editor is the best apology, and it was owing to the want of such a necessary guide that Dr Gleig, the second editor, was perpetually liable, notwithstanding the utmost circumspection, to give, under one title, an explanation of subjects which had before been explained under another; and to omit articles altogether, from a persuasion, sufficiently natural in the circumstance in which he was placed, that they had been discussed in some preceding volume under the general system to which they belong.

We are far from wondering at, or from censuring these imperfections in the last edition. At the same time we may be permitted to observe, that they

they contributed greatly to add to the difficulties of the present editor; since it was absolutely necessary, in order to preserve the unity and consistency of the work, diligently to examine and to compare all those parts of the former edition in which there was any thing unsuitable to the general plan, or in which any interesting information was omitted.

In executing this part of his task, the Editor has encountered many difficulties; but he can truly say he has spared no pains, whether by addition or arrangement, to overcome them, and to present to the public a finished work. For this purpose, he has also availed himself of the valuable information contained in the two supplementary volumes to the third edition, conducted under the inspection of Dr Gleig, which, joined to the more recent improvements of science, he has new-modelled and arranged for the present work.

As it may be satisfactory to the reader to learn by whose assistance the Encyclopædia Britannica has been brought to its present state of perfection, the following list is subjoined, which the Editor flatters himself will be found to contain the names of various writers eminent for their proficiency in different departments of literature and science.

For whatever instruction may be contained under the articles Anatomy, the public is indebted to the late Andrew Bell, F. S. S. A., the proprietor, who had devoted a great portion of his time and attention to the study of anatomy, and to the ingenious Mr Fife, who has practised for many years under Dr Monro, as dissecter in the anatomical school of the University; and the whole article Surgery has been written anew by Mr James Wardrope, surgeon in London.

The articles Aerology, Aerostation, Chemistry, Electricity, Gunnery, Hydrostatics, Mechanics, Meteorology, Mineralogy, with most of the separate articles in the various branches of Natural History, we have reason to believe were originally compiled by the late Mr James Tytler, chemist, but many of them have been entirely re-written, and the others accommodated to the present improved state of these sciences, by Dr James Millar, who superintended the editing of the present work, Dr Kirby, and Dr Brewster of Edinburgh, and Professor Muirhead of Glasgow.

The article Blind was furnished by the late Dr Blacklock and Dr Moyes, both men of superior attainments, the former in elegant literature, and the latter in the physical sciences.

Astronomy and Navigation were compiled, the one by Dr Thomas Thomson, and the other by Dr Andrew Mackay; and the articles Algebra, Conic

Sections,

Sections, Trigonometry, and several others in the mathematical and physical sciences were furnished by Mr William Wallace of the Royal Military College, Great Marlow.

The lives of Johnson and Mary Queen of Scots, with the articles Instinct, Love, Metaphysics, Miracle, the history of Ethics under Moral Philosophy, Oath, Passion, Plastic Nature, Polytheism, Prayer, Slavery, and Supper of the Lord, were contributed by the Right Reverend Bishop Gleig of Stirling, editor of the last six volumes of the former edition; Grammar and Theology by Dr Gleig and the Reverend James Bruce, A. B. late of Emanuel College, Cambridge; and Motion by Dr Gleig. The system of Medicine, which was published in the former edition, was revised and improved for the present by Andrew Duncan, M. D. Fellow of the Royal Society of Edinburgh, and Professor of the Institutes of Physic in the University.

The article Music was furnished by Dr Blacklock for the third edition, and has been considerably improved for the present by Mr George Sandy, writer to the signet, and William Maxwell Morison, Esq. advocate, to the latter of whom the Editor is also indebted for what we have published on the science of Physiognomy. The articles Mysteries, Mythology, and Philology, we owe to the erudition of the late Dr David Doig, master of the grammar school of Stirling, and author of two very ingenious Letters on the Savage State, addressed to the late Lord Kames.

Navigation, Paralax, Pendulum, Projection of the Sphere, and Ship-Building, were furnished by the late Andrew Mackay, L. L. D. long known to the public as an able mathematician; and the article War, including Naval Tactics, by Dr Kirby.

In the former edition, the valuable articles Physics, Pneumatics, Precession of the Equinoxes, Projectiles, Pumps, Resistance of Fluids, River, Rotation, Seamanship, Signals, Sound, Specific Gravity, Statics, Steam and Steam Engine, Strength of Materials, Telescope, Tide, Articulating Trumpet, Variation of the Compass, and Water-Works, were originally written by Professor John Robison. These articles have not been materially altered in the present edition; and to those who are at all acquainted with the various and original acquirements of that author, it is altogether unnecessary to enter particularly into their merits.

Philosophy is the joint production of Professor Robison and Dr Gleig. Physiology was furnished by John Barclay, M. D. of Edinburgh, and Midwifery by Dr James Hamilton, junior. For a continuation of the History of India, the editor is indebted to Dr William Tennant, who resided long in that country. The articles Political Economy and Taxation are written by Mr Hugh Murray; Gardening by Mr James Williamson; and an account of Boscovich's system of Natural Philosophy by Dr Poole. We know that much useful information had been communicated by Dr Latham of Dartford in Kent, the celebrated ornithologist; by Dr William Wright, physician-general to the forces in the West Indies under the command of Sir Ralph Abercromby; by the Reverend J. Hawkins, vicar of Halsted in Essex; by the late Mr Adams, mathematical instrument maker to his Majesty; and by Mr William Jones, optician in Holborn, London.

With every disposition to acknowledge the very able assistance with which we have been favoured in the prosecution of this important undertaking, we are still sensible, that it is wholly out of our power to particularize every one to whom we are indebted. To enter into any detail of the reasons which prevent us from making this particular acknowledgment is wholly unnecessary. We may mention, however, one circumstance, which would of itself have prevented us from being so minute in this particular as we might have wished, namely, the death of Mr Bell, the late proprietor, before the work was finished; to whose great exertions in forwarding this publication, as well as to his zeal in the general cause of science, all those who had the pleasure of his acquaintance can bear witness. While delicacy, however, prevents us from enlarging on this topic, we hope the reader will excuse this tribute of respect to the memory of an estimable character; and that the apology we have made will, at the same time, be deemed satisfactory by those, whose assistance, in the course of the publication, we are in this manner prevented from properly acknowledging.

Edinburgh, July 1810.